# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

No. 16. Vol. II. JUNE, 1893.

## NOTES AND COMMENTS.

### Fog and Vegetation.

AMONG the most interesting of last month's reports is that issued in the *Journal of the Royal Horticultural Society* (part 1, vol. xvi.) by Professor F. W. Oliver, who publishes the second instalment of his observations on the effects of urban fog on plants cultivated under glass. The effect is twofold; in the first place, we have to consider the serious loss of light; in the second, the poisonous substances present in the air.

The general tone of plants, especially of those fond of sunlight, must be considerably lowered by the often long persistent, dull winter weather, with its frequently-recurring fogs. The assimilation of carbonic acid is interfered with, while the transpiration of water vapour from the leaves is almost at a standstill. The roots are not affected, and continue to absorb water from the soil, especially in the case of stove plants, where they are kept by the warmth in a state of marked activity. Hence the cells of the plant become unduly distended with water. Finally, owing to faulty circulation in the intercellular passages, access of oxygen from without is impeded, while the supply normally received from the decomposition of carbonic acid in assimilation is almost entirely cut off; respiration is checked, and substances tend to accumulate in the cells from want of complete oxidation. Thus the whole leaf-mechanism is out of gear. In this enfeebled state the plant is exposed to the attacks of sulphurous acid, hydrocarbons, and other noisome fog constituents, and the result is lamentable, often, indeed, fatal.

Professor Oliver distinguishes two classes of injury, produced by distinct causes. First, cases in which the leaves show local discolourations, particularly at the tips and margins, while the unaffected parts remain fully functional, and the leaf does not fall; secondly,

cases in which the leaves fall, showing either a complete brown or yellow discolouration, or only a partial one limited to the apex, margins, or base, or restricted to minute specks, or irregular patches scattered over the surface. Sometimes the leaf falls uninjured; according to Mr. Watson, during some recent fogs bushels of healthy-looking leaves were gathered up almost every morning in the Palm House at Kew.

The local blotchings of the first class are presumably due to the action of an acid on the upper surface of the leaf. The layer of dirt deposited by the fog contains an appreciable amount of sulphuric acid, the product of oxidation of sulphurous acid. The frequent wetting of the leaves brings this into solution and the drops having a tendency to collect at the tips and margins will leave there on evaporation a deposit of acid. This process is continually repeated until sufficient acid accumulates to corrode the surface.

The changes in the leaf which cause its rapid fall, with or without a colour change, are, the author thinks, largely due to an attack on its delicate unprotected internal tissues. The fog effects an entry through the stomates into the system of intercellular spaces, where its poisonous ingredients come in immediate contact with the moist, delicate, and unprotected membranes of the living cells, which offer but little resistance, and the protoplasm is directly attacked. Whether the leaf succumbs or not depends on the inherent constitution of the protoplasm. The process was carefully followed in leaves of Rhododendrons and others, and the action was found to begin in the lower layers of the spongy tissue next the stomates. Thence it spread to the upper parts of the leaf and the epidermis. In the case of thin uncuticularised leaves when the epidermis is very soft, the noxious vapours may enter directly through the outer layer, as well as by the intercellular spaces. It is not clear to what component of the fog this second class of injuries is due. Owing to the very general absence in the injured leaves of acid products of the green colouring matter, sulphurous acid cannot be the sole agent, and Professor Oliver thinks that some complex organic bases like pyridine may play an important part. As regards remedial measures, there seems but little to be done, except, as Lindley long ago suggested, to keep the temperature as low as is compatible with the life of the plant, with sufficient humidity to avoid desiccation. If the houses are otherwise tolerably air-tight, a contrivance for filtering the incoming air through boxes containing trays of charcoal sticks may be used to mitigate the evil.

---

## A Technical Education Conference.

On April 20 and 21 the Senate House at Cambridge was the scene of a Conference on the relation of Universities to the County Councils in regard to technical education.

The meeting was a representative one. Delegates from the Board of Agriculture, the Agricultural Society, the Oxford and London Universities Extensions, and numerous County Councils met a number of the lecturers of the various societies and others interested in the subject under the auspices of the Cambridge University Extension Board, with the Vice-Chancellor, Dr. Peile, as chairman.

At the first session the "needs of rural districts" and "local organisation" evoked some spirited discussion; a certain difference of opinion was manifest as to the former, while, as regards the latter, a point of vital importance, many of the lecturers had to report a serious apathy on the part of local authorities and persons of influence. Co-operation between neighbouring counties and between County and Town Councils was also the subject of a paper.

At the second session, Professor Liveing spoke on the sequence of subjects of instruction; the meeting then passed to the consideration of the Cambridge and Counties Agricultural Education Scheme. This will ensure a course of two years' instruction in subjects bearing upon Agriculture, including Chemistry—Elementary and Agricultural; Botany—Elementary and Agricultural; Physiology; Geology; Economic Entomology; Book-keeping, Mensuration and Surveying, and Agricultural Engineering. The course will occupy about half of each year, so that those intending to become farmers will have the other half in which to study the practice of farming. Certain Professors and Teachers in the University will admit to their lectures, and to practical instruction in their laboratories, students who, being over seventeen years of age, shall give satisfactory evidence of a sufficient previous education to enable them to profit by such instruction. Several County Councils have voted money for the support of the scheme, while a grant of £100 has been made by the Board of Agriculture. The same County Councils have also offered scholarships to assist promising young men desiring to take the course. Finally, it is hoped that the University will shortly sanction an examination in connection with the course and will grant a diploma to successful candidates.

We wish the scheme a hearty success, and hope that those whose future is to be devoted to farming will take advantage of means which will enable them to become intelligent farmers at a very small cost, and thus go a long way to solve the vexed questions of making agriculture more profitable.

---

## Gigantic Australian Marsupials.

At the last meeting of the Zoological Society of London (May 16), Professor Alfred Newton communicated a letter and drawing from Professor Stirling, of Adelaide, referring to the discovery of a great accumulation of skeletons of *Diprotodon* and other extinct marsupials in South Australia. The find has already been briefly

recorded by the publication of a telegram in the *Times* of April 21, and, judging from the letter, it seems likely to complete our knowledge of the skeleton not only of *Diprotodon*, but also of other extinct Australian animals. The bones are said to occur in a salt marsh in a wonderful state of preservation; but the country is now so hot and arid that the difficulties of digging and transport are very great.

*Diprotodon*, it may be explained, was a wombat-shaped animal about as large as a rhinoceros—the largest marsupial hitherto discovered—and, with the exception of its feet, the skeleton is now almost completely known, thanks to the explorations of Dr. Bennett and others and the researches of Sir Richard Owen. The history of the gradual discovery of the animal is one of some interest. The name *Diprotodon* was first given by Sir Richard Owen in 1838 to the anterior end of a lower jaw obtained by Sir Thomas Mitchell in the Wellington Caves, New South Wales. Five years later, a drawing of part of a jaw with teeth reached England from the same source, and this Sir Richard Owen believed to represent a kind of *Dinotherium*, indicating for the first time the occurrence of primitive elephants in Australia. In the same year, a portion of a molar tooth, associated with the shaft of a femur and other fragmentary bones, was also received, and the same anatomist wrote: "The fossils, which my friend has now transmitted, incontestably establish the former existence of a huge proboscidian Pachyderm in the Australian continent, referable to either the genus *Mastodon* or *Dinotherium*." Only a year later, however, these early surmises proved to be incorrect, and within a short time Sir Richard Owen was able not merely to describe most features in the osteology of *Diprotodon australis*, but also to distinguish another allied genus, *Nototherium*. The feet alone remained unknown, and parts of these were described in the *Philosophical Transactions* of the Royal Society in 1886 as the toes of that fabulous monster, the "Great Horned Lizard of Australia" (*Megalania prisca*, Owen). Complete skeletons, such as Dr. Stirling leads us to expect, will no doubt help much in the determination of minor points and classificatory matters; but the researches of Owen and later authors leave little to be learned about the main features.

---

### The Earliest Monkeys.

In a recent paper on the Eocene Mammals of North America, Messrs. Osborn and Wortman announce their belief that the European *Adapis* and certain allied American forms instead of being, as generally supposed, Lemuroids, are really monkeys. The ground for this appears to be that they have normal lower canine teeth, instead of having the first premolar modified to serve this function. We cannot, however, see that this is a valid reason for their separation from the Lemurs, the earlier forms of which, in our view, were probably ancestors of the Monkeys. This, however, we suppose, is nowadays heresy.

### The Ancestors of the Cat.

The above-named authors in the same communication put forth the hypothesis that the cats, instead of being directly related with the other Carnivores of the present day, are independently descended from the Creodont genus *Palæonictis*. In view of the close similarity between the Cats and the Civets (the latter being clearly related to the Dogs), this is "parallelism" with a vengeance. Does it never strike the promoters of such extreme views that by proving (!) the want of relationship between apparently closely allied animals they may be cutting away the ground from beneath the foot of the evolutionist, since, if resemblances are, so to speak, fortuitous, why should not we revert to the doctrine of separate creations? That parallelism does exist in Nature, we are fully prepared to admit, but it is not omnipresent. However, when once the ball is set rolling in a certain direction, everyone thinks it necessary to give it another push.

---

### Aërial Roots of Orchids.

The velamen, or characteristic external covering of the aërial roots of epiphytic orchids, forms the subject of a note by P. Groom in the last issue of the *Annals of Botany*. As terrestrial orchids are almost invariably devoid of a velamen, it is usually assumed that the aërial orchids acquired theirs subsequently to the adoption of an epiphytic mode of life, but it is suggested that the few exceptions may indicate the existence of the covering in a previous terrestrial mode of life.

With a view to getting some light on the date of origin of the velamen, the author has made observations on *Grammatophyllum speciosum* and species of *Bromheadia*, both at Singapore. The former is one of the few orchids which grow naturally both as terrestrial and epiphytic plants, and can be found growing in the jungle when it has happened to fall off a tree. When a terrestrial plant, the velamen is not only retained but even strongly developed in the soil, while the upwardly-growing aërial roots characteristic of the epiphytic habit, which Schimper has shown to be respiratory organs, are still developed.

*Bromheadia alticola* lives in the full blaze of the sun on high tree tops, and has a peculiar two-layered velamen, while in *B. palustris*, which is terrestrial, the velamen is fundamentally similar, but lasts only for a short time, peeling off and disintegrating. This points to the conclusion that this covering is essentially adapted to epiphytic plants, and was evolved subsequently to their assumption of an aërial mode of life.

The two sets of observations seem to give contradictory results. In the first, the velamen being more highly developed in the subterranean; in the second, in the aërial roots; but the explanation is found in the fact that the function of the structure varies. In *Grammatophyllum* it is essentially an absorbent organ, which not only

persists, but is more highly developed, while the root becomes subterranean; whereas in *Bromheadia* it is mainly protective, preventing loss of water, while the absorptive function is carried on by root-hairs borne on the lower surface, which, in the terrestrial species, are reduced to strongly cuticularised papillæ.

Hence, in the aërial branches of the subterranean roots of *Grammatophyllum* the velamen dwindles, while in the subterranean roots of *Bromheadia* it peels off so as not to interfere with the process of absorption.

## Science and Dictionaries.

The explanation of the sins of omission and commission in scientific words in dictionaries would task the acutest mind, and it is very dismal to notice that Dr. Murray's monumental English dictionary is not conspicuously better than its less ambitious predecessors. In an idle hour we dipped into the "A's" and brought up the following:—

Sins of omission—

Alecithal: Amphiblastula: Analogy (in its scientific opposition to "homology"): Asteroidea: Anamniota: Anthropomorpha: Acœlous or Acœla.

Sins of commission—

Ascidian—A group of animals belonging to the Tunicate Mollusca: considered by evolutionists to constitute a link in the development of the Vertebrata.

Anthozoa—Another name for the zoophites called Actinozoa.

## The Imperial Institute.

Fellows of the chartered scientific societies have received so many pressing invitations to become Fellows of the Imperial Institute that they have long been anxiously awaiting a definite statement of the privileges and work in which they might share. Since the opening by the Queen, on May 10, their wish has at last been gratified by the appearance of an advertisement, which is strongly suggestive of that of the Crystal Palace and the Earl's Court show, and seems to explain that the Institute is to be another summer resort for Londoners. A music and dancing licence has been obtained, and on four days a week the public are to be admitted to the entertainments at popular prices. "Tea, coffee, and other refreshments will be served from the garden kiosks. . . . Seats and tables may be reserved in the public dining-rooms by making application to the dining-room superintendent. . . . The full band of the Royal Artillery will play daily in the kiosk of the West Garden. . . . Entertainments of vocal and instrumental music will occasionally be given in the Great Hall and the Indian Pavilion." Fellows and their friends have the sole enjoyment of these privileges on Wednesdays and Fridays.

### Cholera.

The May number of the *New Review* has a sensible and readable article by Dr. Robson Roose on the propagation and prevention of cholera. Numerous cases are cited in illustration of the intimate relation between the water supply and cholera outbreaks, and hence the supreme importance of the purity of water used for drinking. The author does well in pointing out that dirty filters are worse than none at all; unless it is from time to time cleansed or renewed, fairly good water may actually take up impurities from the filter. If charcoal be the agent it should be boiled occasionally, say once a month, and then dried in the sun or an oven. Spongy iron filters are recommended for general use as being cheap and easily renewed. The fact that water is cool and sparkling does not imply purity. An outbreak in Golden Square in 1854 was traced to a well, the water from which was much liked for having these characteristics, but on examination was found to be contaminated by leakage and filtration from a cesspool. The general rules for prevention of the epidemic are those of ordinary hygiene, cleanliness in all things, moderation, and care in diet and exercise. The fact that more than five-and-twenty years have passed since cholera gained a footing in this country, though it has from time to time reached our ports, may fairly be attributed to the improved sanitary conditions which now obtain in all our large towns.

---

A study of the range of the Molluscan genus *Placostylus* has lately led Mr. C. Hedley to generalise in reference to the ancient geography of the region of New Caledonia, the Solomon Isles, New Hebrides, and Fiji Isles, and their connection with New Zealand (*Proc. Linnean Soc. N. S. Wales*, ser. 2, vol. vii., 1893, pp. 335–339). He thinks that these islands form part of a shattered continent, never connected with, or populated from, Australia, but rather deriving their fauna from Papua *viâ* New Britain. The presence of genera common to Australia and New Zealand is explicable on the ground that they migrated, not from the one territory to the other, but each from a common source, New Guinea. New Zealand and New Caledonia seem to have been early separated from the northern archipelagoes and to have ceased to receive overland immigrants therefrom. Finally, the Fijis appear to have remained to a later date in communication with the Solomons, though severed from that group before the latter had acquired from Papua much of its present fauna.

---

The problem of stocking a pond with fish receives an unexpectedly bold solution in our contemporary *Illustrated Scientific Facts* (April 15); it is there said that, as the bottom of many ponds consists of soil which was once the bottom of the sea, it probably abounds in spawn deposited, say, by the fishes of the Old Red

Sandstone; the vivifying influence of the water hatches out the spawn, and hence the appearance of fish. The paragraph is gravely worded, and there is not the least indication that it is "writ sarcastic."

---

IN the *Trans. Entom. Soc. Lond.*, 1893, pp. 191–9, Dr. D. Sharp describes the very remarkable eggs of a Reduviid bug from the Amazon valley. The eggs were closely arranged on a leaf, and a wasp, supposed to have been killed by the mother bug to furnish food for her young, was entangled in the mass by the wings. Each egg is cylindrical, the upper part containing a conical, crown-shaped structure, composed of a system of network and tubes believed to afford entrance to spermatozoa. This cone is pushed upwards by the young bug in emerging, and the upper part of the egg-capsule, which has kept it in place, is ruptured. Numerous parasitic Hymenoptera were bred from the two outer rows of eggs, the cones of which had not been lifted. It seems that the habit of laying the eggs in a serried mass secures the safety of the majority within by the sacrifice of these outermost rows, beyond which the ovipositor of the ichneumon-fly cannot penetrate.

---

AN interesting paper on the Pupæ of Moths, by Dr. T. A. Chapman, appears in the latest number of the *Trans. Entom. Soc. Lond.* (1893, pp. 97–119). He distinguishes two principal types:—the obtected pupa, which has a hard, even surface, with the skin of the appendages closely attached to that of the body, and with the fifth and sixth abdominal segments alone capable of movement; and the incomplete pupa in which the appendages are more or less free, maxillary palpi are present, and three, four, or five abdominal segments can be moved. The obtected pupa, also, has no power of progression, but the incomplete generally emerges from its cocoon before transformation into the moth. The division of the moths by means of these pupal characters roughly corresponds with the old division into Macro- and Micro-lepidoptera, but the Pyraloids, having obtected pupæ, are classed with the higher moths, while the Zygænidæ, Sesiidæ, Cossidæ, Hepialidæ, and Limacodidæ are placed with the Tineids, Tortricids, and Micropterygids. Most of these changes have been suggested by naturalists working mainly by the neuration of the wings; the confirmation afforded by this distinct line of research will hasten the general acceptance of the new views.

---

AT the meeting of the Entomological Society of London on March 8, Dr. Sharp read a paper on Stridulating Ants. He said that examination revealed the existence in ants of the most perfect stridulating or sound-producing organs yet discovered in insects. We have only received the abstract of this paper, and must wait fuller details before commenting on it.

SEVERAL contributions have lately been made to knowledge of the distribution of the mollusca. Mr. A. Everett has made extensive collections of land-shells in Borneo and the Philippine Islands, and these have been described by Mr. E. A. Smith (*Journ. Linn. Soc. Zool.*, vol. xxiv., 1893, pp. 341–352, pl. xxv., and *Ann. Mag. Nat. Hist.* [6], vol. xi., 1893, pp. 347–353, pl. xviii.). Mr. A. Abercrombie has collected 320 species of mollusca on the coast of Bombay, and 25 are determined to be new by Mr. Cosmo Melvill (*Mem. and Proc. Manchester Lit. and Phil. Soc.*, vol. vii., 1893, pp. 17–66, pl. i.). A list of 205 species from the Seychelles is also given by P. Dautzenberg (*Bull. Soc. Zool. France*, vol. xviii., 1893, pp. 78–84).

---

THE *American Naturalist* for April contains an article, by Professor E. D. Cope, on the Genealogy of Man. Professor Cope agrees with M. Topinard in believing that the Hominidæ descended directly from the lemurs, without the intervention of the Simiidæ. A special feature of this article is a plate showing the peculiar character of the grinding faces in the teeth of the Palæolithic men of Spy.

---

THE vexed question of Man and the Glacial Period is discussed over twenty pages of the *American Geologist* for March. Messrs. Shaler, Wright, Leverett, Upham, Claypole, Winchell, Hitchcock, and Putnam contribute to the discussion, which has apparently been induced by the publication of Professor Wright's book, noticed in this Journal for February. There are also some papers on Glacial deposits; and those on Pleistocene Geology, read at the Ottawa meeting of the Geological Society of America, held in December, 1892, also appear in print.

---

ONE result of the recent excursion of the Geologists' Association to Norfolk (to which we called attention in our April issue) was the finding in the Norwich Crag, at Bramerton, of a portion of an antler of *Cervus sedgwicki* ?, Falconer. The specimen was obtained by Mr. R. W. Hinton, and identified by Mr. E. T. Newton. Although named with a query, it belongs to a form hitherto not recognised out of the Cromer Forest Bed.

---

THE subject of chlorophyll in animals has just been discussed again in a lengthy article by Dr. E. L. Bouvier (*Bull. Soc. Philom. Paris* [8], vol. v., 1893, pp. 72–149). He admits that the green colouring matter is sometimes diffuse in Infusoria, but he considers that in the large majority of cases there is distinct proof that it occurs solely in symbiotic algæ of the family Palmellaceæ. He points out that these green specks are frequently found free in the water, and in that case they multiply by zoospores like the isolated algæ of certain lichens. He has also observed the inoculation of organisms by these free chlorophyll-bearing cells.

A recent number of the *Farmers' Bulletin* (no. 10), issued by the United States Department of Agriculture, describes the Russian Thistle, *Salsola kali*, the Prickly Glasswort of our sandy sea-shores, as one of the worst weeds ever introduced into American wheat fields. One year's damage in Dakota alone is estimated at 2,000,000 dollars. The bulletin reports that it takes complete possession of the soil, while its spiny nature makes it objectionable to horses and other animals.

---

In *Le Naturaliste* of March 15 Henri Coupin argues that zygomorphy of the flower, that is, symmetry in relation to a single plane, is primarily for the purpose of protecting the pollen from rain, while adaptation for pollination by insects is only a secondary consideration.

---

The "Dictionnaire Pratique d'Horticulture" is an improved translation of Nicholson's well-known Dictionary of Horticulture. It is edited by M. S. Mottet and is, says the *Gardeners' Chronicle* of May 6, "indispensable to all who read French, as it is more complete than the original edition, and contains several additional features." It is issued in parts by Octave Doin of Paris.

---

The *Journal of Botany* has been showing a tendency towards Cryptogamic Botany during recent years. In the April number, there is a paper on Fresh-water Algæ, one on Marine Algæ, one on a Moss, one on Hepaticæ, and a long obituary notice of a Cryptogamic Botanist. The editor probably means no more by this than that Cryptogamists (even though one fewer) are getting too many for him.

---

Mr. Herbert Spencer has issued a reprint of his articles on "The Inadequacy of Natural Selection," followed by that on "Professor Weismann's Theories," appearing in the *Contemporary Review* for February, March, and May, 1893. The pamphlet is published by Messrs. Williams and Norgate.

---

Professor Logan Lobley has in the press "The Parishes of Surrey: their Surface Features, Geological Structure, and Natural Resources." The book will deal with the 148 parishes in the county, which will be taken in alphabetical order. It is proposed to treat the subject in as practical a way as possible, and to render the volume a thoroughly useful compilation.

We have had the opportunity of seeing a specimen copy of the first part of Mr. Lydekker's "Royal Natural History," and are glad to be able to report on the splendid style in which this important work is got up, the illustrations looking far better when set up among English type than they do in Brehm's ponderous tomes among German letterpress. If this part be not in the hands of our readers by the time they peruse these lines, we believe it will be issued in the course of the current month.

---

Mr. J. W. Gregory has decided, with characteristic energy, to push on through the Mount Kenia country to Lake Barengo, and proposes to return by the unfrequented Sabaki route. The district is fairly healthy, there are many geological and zoological problems awaiting solution, and we trust that he will be successful in doing good work; he may thus save the reputation of the Villiers Expedition, so seriously injured by its originator. Sir Gerald Portal's cautiously worded reference to Lieut. Villiers was quoted in our April number.

---

The Government of India has decided to dispense with the services of natives as Geological Surveyors. The reason for this decision is stated to be, that habits of observation and practical enquiry are not sufficiently developed in the Hindoos by the present system of education. We also understand that the Government has issued further orders restricting the work of the Surveyors to questions of economic interest.

---

We have received the *Bulletin of the Geological Institution of the University of Upsala*, vol. i., no. 1, edited by Professor Hj. Sjögren. This is a new serial, and is intended only for papers worked out at the Geological Institution of the University, or based on material belonging to the collections of the Museum. At present, it is proposed to issue a yearly number, which will contain a report of the meetings of the geological section of the Upsala Students' Association of Science, in addition to the original articles. Subjects may be treated in French, German, or English. The present number opens with "Contributions to Swedish Mineralogy," by the editor, in which Axinite, Hedyphane, Humite, Chondrodite, Clinohumite, Longbanite, Szabite, and Adelite are treated, the last three being recently-discovered forms. C. Winran writes "Ueber das Silurgebiet des Bottnischen Meeres"; O. Nordenskjöld on "Der Hälleflinten des nordöstlischen Smålands"; and J. G. Andersson on "The Occurrence of the Paradoxides ölandicus-zone in Nerike." The *Bulletin* is illustrated with five plates of minerals.

# I.

# Flowers in the Guiana Forest.

THE "spicy breezes" of the tropics are proverbial, and many travellers have written on the beautiful flowers and their perfumes. According to the popular notion, these odours are perceptible at considerable distances from the coasts, and greet the weary mariner almost before he sights land. This, however, if not altogether untrue, is highly exaggerated. When there is a land breeze, it more generally brings with it a heavy stifling odour redolent of the mangrove swamp and decaying vegetation, no doubt recalling memories of the forest, but rarely pleasant, and, sometimes, even disagreeable. On the rivers, where a heavy mist hangs at night, perfumes are sometimes wafted to considerable distances, but rarely can they be detected at sea, probably because there is always some motion in the air which disperses the vapour.

The ordinary visitor, with exaggerated notions of the beauty of tropical flowers, expects to see them here, there, and everywhere, and is naturally disappointed when he finds so many trees and plants with, what he considers, no blossoms at all. Coming from meadows dotted with moon-daisies or golden with buttercups, he sees only a few inconspicuous weeds, with here and there a yellow rattle-bush (*Crotalaria*), or the blue *Ruellia tuberosa*. In the gardens, however, he can hardly fail to be struck by the size and beauty of the numerous species of *Hibiscus*, *Convolvulus*, and *Bignonia*, but these are not wild flowers.

The true native plants are neither to be found in field nor garden in the cultivated districts. To see them he must paddle along the rivers and creeks, walk on the sand-reefs, and explore the savannahs; but, even here, he will be disappointed if he expects to see anything like a continuous stretch of colour such as gratifies the eye on an English down or mountain slope. The flowers in the tropics do not grow in great masses, like heather, furze, or broom, but one species here and another there, rarely in anything like a clump, or even scattered in any considerable number. Then they do not all open at the same time, but some are earlier and some later, even in the same species. Again, few remain open for any lengthened period; some can only be seen by the early riser, as they close soon after sunrise,

while others unfold with the dawn and droop and wither in an hour or two.

Wallace, in his "Tropical Nature," heads a section, "Comparative Scarcity of Flowers," and states that "conspicuous masses of showy flowers are so rare, that weeks and months may be passed without observing a single flowering plant worthy of special admiration." This is such a sweeping assertion, and so contrary to the facts, that, notwithstanding the author's status as an authority on the tropics, we can hardly do other than try to refute it.

In the dark arches of the forest scarcely a flower is to be seen; but even here we often come upon a litter of golden or crimson petals which have fallen from above, so that, although we cannot see that the tree is flowering overhead, we know it must be a magnificent spectacle if we could only rise above it. Along the banks of the rivers and creeks there are always flowers, sometimes few, sometimes many, but at no time entirely wanting. Most of these are borne on creeping and scrambling vines, some are particularly showy, and even an ordinary observer must admit that many of them are worthy of special admiration. Again, there is the sand-reef where the low bushes, at certain seasons, are decked with flowers, which can be easily seen, and are by no means rare.

One of the reasons why so few flowers are noticed is because they are not looked for at the right time. It cannot be expected that forest trees will be in flower all the year round, although they may blossom twice instead of once in twelve months. In Guiana the flowering seasons are in February and March, and July and August. During these periods masses of showy flowers are common, although many of them are so far above our heads, or so hidden by the forest canopy, that we can only get an imperfect glimpse of them.

The expanse of green foliage is so great as almost to overpower all but the most gaudy flowers. Whites and all dull colours are obliterated, and even yellows combine with the sunlit green in such a manner as to be invisible at a distance, unless, as in the case of the etabally (*Vochysia*), the whole tree is covered with flowers. The large waxy-white flowers of the clusias and yellow and cream Malvaceæ, are quite invisible, while the great spikes of Mimoseæ can hardly be seen from the ground unless specially looked for. Rarely does a tree become bare at the time of flowering, and even when this takes place the individual is almost lost in the great crowd. The foliage is so dense that we can only compare the expanse to a roof. When Wallace states that from some elevated point you often gaze down upon an unbroken expanse without a single patch of bright colour, he speaks the truth, but it does not follow that there are no showy flowers there. Take away the background of foliage, if this were possible, and many a brilliant group of flowers would appear. Even in an English orchard the difference between those trees which flower before and those with the leaves is enormous.

A great many forest-trees have greenish-white or green flowers. These are, of course, very inconspicuous at all times, but they by no means eclipse those with showy flowers. Rarely do even two or three of a species come together, so that there will be always some of the more conspicuous even in a small area. When we mention that the predominant natural order is the Leguminosæ, it will be seen at once that there can be no scarcity of flowers. This family is a host in itself, the various forms of Papilionaceæ, Cæsalpineæ, and Mimoseæ all combining to make an interesting and showy collection. Then there are the monkey pots (Lecythideæ), all of which have large and highly-coloured blossoms; but the most conspicuous tree is, undoubtedly, the etabally (*Vochysia*), which, during the season, is a canopy of gold, the result of flocks of sulphur-coloured butterflies.

It is unnecessary to give a list of the different families which make up the forest flora. They are so numerous and varied, so different from anything in the European woods, as to be most striking to the ordinary observer, and a continual source of interest to the botanist. It is, however, their beauty of foliage which compels attention at first; the shapes and sizes of their leaves, their luxuriance, and their continual struggle to occupy every little patch of sunlight to the exclusion of all others, which prevents the forest from ever becoming dull or monotonous.

Book illustrations rarely give any adequate representation of forest scenery. If they are not conventional they are generally almost caricatures. Artists have attempted to picture some of the most striking peculiarities, but even they only observe the superficial. Appun's illustrations in "Unter den Tropen" (Jena, 1871) are among the best, and as nearly true to life as a draughtsman can make them; but in the whole series there is hardly a flower, this proving that the artist was impressed by the foliage almost to the exclusion of everything else.

In paddling up a creek the canopy of forest-trees is so far overhead as to be out of the line of sight. Every bend brings into view a new scene. Clumps of graceful palms, masses of gigantic creepers, jungles of tree-ferns intermingled with the contrasted foliage of marantas and heliconias, and great aroids which climb almost every tree or perch on their branches, all combine to leave an impression of rampant vegetation which eclipses the most gaudy assemblage of flowers.

But, with all this, flowers are not wanting. Great bunches of yellow bignonias, dipladenias, allamandas, scarlet noranteas, combretums and cacoucias, with spikes which glow like fire in the sunlight, a hundred species, of various shades, from rosy crimson to purple; and last, but by no means least, the tubular Cinchonaceæ and other white flowering plants, the clusters of which often show up quite prominently against the dark background of foliage. Some of those with lurid flowers are by no means inconspicuous. The

species of *Mucuna*, which hang their flowers on long strings, one of our commonest timber trees; the wallaba, with similar blossoms; the *Marcgravia*, with its curious pitchers; and several bushes and trees with their flowers sessile on stems and branches, all go to add to the interest of forest scenery.

As if this were not enough, many of the shrubs and lower-growing plants have coloured bracts. Almost but not quite hidden by their handsome foliage, the heliconias glow with a fire-like brilliancy, and some of the marantas, although not so conspicuous, still show up well among their great leaves. A species of *Cephaëlis* has large scarlet bracts, and other plants of the same family come to the front in a similar way. Tillandsias, which are epiphytal, and have inconspicuous flowers, often shine up on the edge of the forest owing to their scarlet bracts.

Colour is by no means wanting in the leaves. The great family of Melastomaceæ, so characteristic of the American tropics, stands out most prominently as an example of beauty in form, venation, and colour. Many of the species have a crimson glow over their whole surface which marks them out from their dark-green neighbours. Their flowers, although not generally showy, are always elegant, and their dark purple fruit very pretty indeed. The young seedlings of forest trees have always two or three of their upper leaves glowing with those delicate shades which are so conspicuous at the change of seasons, and low-growing marantas are often striped with rosy or white lines. Large patches of ferns and selaginellas also cover the ground on the edge of the forest, and with their lighter tints contrast with the dark greens and browns.

Only in the dense forest, where perpetual twilight reigns, are the tree-trunks quite bare. Along the river banks, borders of the savannahs, and sand-reefs, every stem is more or less clothed with creepers. Some, as *Vanilla* and *Marcgravia*, climb like ivy, their leaves lying almost flat, others festoon the tree with garlands, while the immense heart- and arrow-shaped leaves of the giant aroids congregate at the top, almost covering their host. Other great plants of the last-mentioned family sit on the upper branches and throw down long aërial roots, the size of thick twine, which branch into masses of fibres as they reach the water. Mosses are not so plentiful as in temperate climates: they are replaced by patches of ferns, some of which are particularly delicate. Species of *Trichomanes* often extend up the trunks for several feet, where they are replaced by *Polypodium piloselloides*, and higher yet by *Peperomia nummularifolia*. These form cushions on which small epiphytal orchids, ferns, tillandsias, and gesnerias find congenial habitats, all combining to decorate the otherwise bare stems and branches.

To return to the flowers. Away from the rivers and open spaces, they are almost invisible, and even when seen many of them are inconspicuous; but, although hidden from sight, they make their

presence known by their perfumes. They may be of that greenish white which is hardly distinguishable from the background of foliage, and yet be able to attract myriads of nocturnal insects. Pass by at any time in the day and not the faintest trace of perfume lingers upon them, but paddle along at night and you wonder whence comes the overpowering fragrance.

Diurnal flowers and insects are comparatively scarce when contrasted with those of the night. The great tubular blossoms which glow in the sunlight are visited by humming-birds, butterflies, and bees, but the hum and whirr of insect life, so characteristic of night in the forest, is almost wanting. Where a few butterflies may be seen fluttering lazily from flower to flower at noon, after sunset moths are attracted in numbers by the great white blossoms, or the fragrance of thousands of smaller and less conspicuous flowers.

How difficult it is to trace these perfumes. Sometimes it is quite impossible. Who recognises the odour of the mora[1] flowers, or knows anything of the numerous scents that are wafted across the narrow rivers after nightfall? As certainly as we see a particular kind of whitish flower, we can confidently state that it is odoriferous at night, but hardly a single species is known in this way. In passing along the creek, a perfume is suddenly wafted across, but where it comes from is a problem not easily solved. Even that common orchid, *Epidendrum nocturnum*, which derives its specific name from the fact that it distils its perfume after nightfall, is rarely known by this character. We have seen cases where these orchids have been kept for years without their owners knowing anything of their perfume, and when it was discovered, this came about by the accident of bringing a plant into the house for an evening. Other orchids are quite as peculiar in this respect; a most delicious odour may be perceived at one particular time, and not be appreciable at any other.

Some flowers open for an hour or two, and then, whether fertilised or not, droop and wither; others are able to try again perhaps at the same time next morning or evening. Those which do not fall may still have their particular time for fertilisation, when it appears as if every effort is strained to attract the particular insect whose agency is so urgently required. It is surprising to find that so many are successful in these efforts. Even when their odour is not appreciable to us, the bees find them out. They may be hidden away under a tangle of bush-ropes, and not a single insect of the species required be visible in the neighbourhood, but somehow or other, as the flowers open, the bees or moths appear in considerable numbers.

Flowers must be peculiarly sensitive at these times. Some, as

[1] A gigantic timber tree, belonging to the family Leguminosæ, and forming extensive forests in British Guiana. It grows from 130 to 150 feet high, and produces a very tough and close-grained wood, which is imported into this country in considerable quantities for ship-building, even rivalling oak in its non-liability to splinter. The bark is astringent, and useful for tanning.—ED.

we know, have their temperature raised several degrees, and, probably, all are more or less heated for the short period when they are prepared for fertilisation. Several species of *Hibiscus* go through a series of changes of colour from morning to evening; the *Victoria Regia* opens the first night as a waxy white flower, and the second with rosy petals. Several orchids also change colour very quickly, especially after their work is accomplished. In a few hours the plump waxy petals become limp, the markings spread and get diffused over the lip, and the whole flower becomes unsightly. Where there are male and female flowers the latter often lasts much longer, and may even be perceptible for months at the apex of the seed-vessel.

What an important crisis in the life of the plant is its flowering time. All its energies appear to be directed to this one end and aim. We can hardly look upon it as merely vegetating, but as an individual straining to accomplish the greatest work of its lifetime. There are so many little things to be considered that, whatever our ideas of Natural Selection and the chance survival of the fittest may be, we are bound to think of them as sentient beings. When a man fixes an hour for performing certain work, and that is the most suitable and perhaps the only possible time for accomplishing it, he does little more than the orchid, which, apparently, knowing that its friend the insect will be on the wing from midnight to dawn, opens its flowers and circulates its perfumed invitations through the neighbourhood only during those few hours.

We say, perhaps, that these actions are instinctive, but what is instinct? Is it not the accumulated experience of all past ages? Every individual, whether animal or plant, may be considered as a link in a long chain of beings, the origin of which goes back to some past age when the common ancestor was nothing more than a simple cell. During this long period, in which so many generations have passed away, what a wealth of experience must have been gained. Is this lost at the death of the individual? On the contrary, do we not see that every organism has the stamp of its parentage, and we can hardly be wrong in saying that not the slightest impression has been made on any individual that is not perpetuated in its offspring. These impressions may remain latent for generations, but nevertheless be ready to come to the front at any time according to circumstances.

Suppose we compare these to a composite photograph and call them physical memories, is it not necessary that there should be some power of selection? Is everything done mechanically as reflex action? Can we not conceive that there may also be physical reason, which works unconsciously, but at the same time always towards certain well-defined ends? When we go to sleep at night with the intention of waking at a certain hour in the morning, and do so perhaps to the minute, physical memory and physical reason

has perhaps kept the record for us and done it well. That something of the same kind is at work in every plant and animal is so obvious that it can hardly be disputed.

It is utterly impossible to conceive of such curious and wonderful contrivances as are found in the orchids, especially *Coryanthes* and *Catasetum*, originating without a purpose, and being perpetuated only by the chances of Natural Selection. Given physical memory and physical reason, we see at once that the difficulty is reduced to almost nothing. For ages environment has been at work moulding every part of the plant as it were, until it has become what we see it to-day; but it cannot remain on the same level; it must either advance or go backwards. Here individuality comes in. Why does every plant and animal differ from every other? With the same inherited characters, and grown under circumstances apparently identical, two seeds from one capsule produce trees differing more or less from each other. Natural Selection may account for a great deal, but it can hardly explain the origin of variation. Taking into account, however, the fact, that flowers are extremely sensitive at the period of fertilisation, is it not possible that impressions may be made on the plastic germ-cells which affect the new individual? The seeds in one capsule may not be all impregnated at exactly the same time, and circumstances may occur in an hour, or even a few minutes, which affect the one individual, then at the most critical stage of its existence, to the exclusion of others in different stages.

Many insects and plants die soon after impregnation, the males almost immediately, and the females as soon as the germs of their offspring are sufficiently mature. It follows, therefore, that the end and aim of their whole life is to bring forth new individuals. Plants can be increased by budding and other than sexual connection, but it is doubtful whether the portions so divided are equally strong with those raised from seed. They are not individuals to the same degree as if raised from two parents with different experiences. Then, again, they have not passed through that critical period when the germ-cell was highly susceptible to every external influence.

Looking upon the trees of the forest as individuals, how interesting they appear. Sometimes we may fancy them conscious, and, instead of feeling lonely in their midst, rather think that we are in good company. No longer vegetating, they live, strive to do their duty, look out for "number one," and aim at perfection. The great scrambling creepers seem to know how to get ahead at the expense of others, growing longer or shorter according to circumstances, sometimes turning to raise themselves to great heights, or at others forming dense bushes. One species has succeeded by some peculiar contrivance, and its neighbour by means entirely different. They twine round or adhere to the tree-trunks as long as it suits their convenience, and then stretch forth on every side, or perhaps hang in long streamers almost to the ground. The mangrove extends its long

slender arms downward, and branches into fingers as it nears the water, feeling its way, as it were, to the most congenial places. Near it is the courida, which anchors itself in the mud in a different manner and has given up using props. But there at intervals up the trunk are large excrescences covered with aborted aerial roots which seem to indicate similar possibilities in this tree also.

Other examples are continually forcing themselves on the attention of the naturalist, all going to prove that plants are something more than creatures of circumstance. After making every possible allowance for the influence of light, heat, and moisture, there still remains the apparent selective power, which only seems to differ in degree from that possessed by animals. Without the power of locomotion, they yet extend their roots to great distances, feeling around, as it were, for congenial food, and if they fail in one direction try several others. Then their branches are condensed at the apex, or spread out from the base upwards, according to the situation, the same species, in different places, appearing quite distinct in shape and size.

But where do we find such examples of apparent selection of means to particular ends as in the orchid family? When certain species provide quarters for a garrison of carnivorous ants, it is easy to say that the insects found the bunch of aerial roots suitable for a habitation, and that the plant did nothing. But when we see that only a few orchids have developed contrivances to this end, and the great advantage they derive from them, we cannot but look upon them as designed for the purpose. In some cases they are so well placed as not only to defy every larva and cockroach, but even man himself. In our own experience, we have had to pass on and leave a fine plant, because we could not risk the bites of such a host as swarmed out at the least touch.

Some flowers, as we know, secrete nectar for the express purpose of feeding the insects they attract by their colours and perfumes. Others attract, but provide nothing, yet the blundering insect still fertilises it in his search for what is not there. When boys play similar tricks, we call them practical jokers. Has the plant done this either accidentally or mechanically? Some go so far as to provide traps by which insects are caught and utilised; are these contrivances also due to chance? In the *Coryanthes* we have a marvellous collection of means to a particular end, *i.e.*, the fertilisation of its flower. By means of its perfume and colour it attracts bees, only to give them a bath from which they can escape by doing its work. If a man does something of a similar kind we consider him rather clever, although, perhaps, not very honest. It is now generally conceded that animals are reasonable beings; to go a step farther, and allow the same to plants, is almost as necessary. It does not follow that because a dumb man cannot explain his thoughts that, therefore, he has none. When the strong man bears pain without flinching, is it

because he feels less than the baby who cries out at the top of his voice? It is a matter of common observation that plants show their likes and dislikes, suffer and languish when sick, brighten up and look robust in congenial positions, and have, to a certain extent, most of the faculties common to man and the lower animals. True, they cannot see nor hear, but their sense of feeling is very acute, and we may conclude that even taste is not wanting.

James Rodway.

## II.

# Biological Theories.

### V.—SUGGESTIONS AS TO THE TRUE FUNCTIONS OF "TENTACULOCYSTS," "OTOCYSTS," AND "AUDITORY SACS."

SUCH a jelly-fish as Aurelia has eight minute finger-like bodies lodged in little pouches in the edge of the umbrella or swimming-bell. The tip of each is weighted by a calcareous deposit within it, and the stalk is hollow, the cavity of the gastro-vascular system extending into it. To the whole organ, that is, to the diminutive tentacle and its pouch together, the name "tentaculocyst" is applied, and the function performed by the eight such organs is a subject which I propose to consider first.

The large nerve-supply has led to the belief that the tentaculocyst is a sense-organ, and it is not infrequently described as a combined visual and auditory organ. That it is not auditory, I have already shown. That it is sensitive to light is a reasonable conclusion from the presence of pigment, but that does not explain its structure. A simple pigment spot without pouch or tentacle would serve that purpose quite as well. There is, moreover, a wide difference between an organ sensitive to light and a visual organ, for "sensitive to light" does not necessarily mean giving rise to a sensation when light falls upon it. It may be that light produces a stimulus when it falls on a pigmented patch, but unless that stimulus gives rise to a sensation of some kind or other, the organ should not be called visual. A reflex muscular contraction may follow upon the stimulation by means of light, but that by no means shows that sensation has intervened. Little as we know of the psychology of these lowly-organised animals, we are justified in doubting, if not in denying, the possibility of consciousness and, therefore, of sensation. It is nearly impossible to believe that consciousness, and judgment, and intelligent action upon the basis of knowledge received by means of sense-organs is possible in an animal with a nervous system so lowly-organised as that of a jelly-fish, especially of a Scyphomedusa, and an explanation of the function of these organs which is free from any such assumptions as these would, therefore, seem to be called for.

If, however, these were auditory organs, as has been supposed by

many, the fact that there were eight of them would be difficult to explain, though, of course, it might be suggested that this was necessary to enable the animal to determine the direction in which the sound reached it; but, even then, the limited powers of locomotion would seem to render such a sense useless, and hence the evolution of the organs could not be explained by Natural Selection, nor yet, since the animal has no vocal organs, by sexual selection.

Temperature may, perhaps, affect them, but if so surely it would affect all alike, and eight would not, therefore, be more useful than one or two; nor is their structure explicable on the hypothesis of sensitiveness to temperature.

It may be well, therefore, to enquire what are the conditions under which the animal lives, and what are the dangers to which it is exposed.

The danger from living enemies may be left out of account, for the abundant supply of thread-cells and the very small percentage of matter useful for food which they contain make them almost useless as food for other animals, and, even if it were not so, they have no means of escaping from any animal which might pursue them.

These animals are pelagic, that is, they live in the open ocean, near its surface. The tissues of the body are so delicate that it is difficult to lift one from the water without tearing it to pieces. The dangers of the storm-tossed surface of the ocean for such an animal are, in part at least, obvious, but it is less obvious how they are avoided, especially if the animals be devoid of judgment and even of consciousness. The view I propose to offer is, that the tentaculocysts, without giving rise to sensation, serve to automatically steer the animal in such way as to keep it out of the way of its chief dangers and, at the same time, in the region where its food most abounds. How this is effected can only be made clear when we know something about the nature of the disturbance which we call a wave.

It is not easy to know very much about a wave without also knowing more about certain branches of higher mathematics than is usual among zoologists. Parenthetically, I may, as a biologist, admit that the Senior Wrangler who defined a biologist as "a man who cannot solve a mathematical problem," came sufficiently near the truth to make the epigram a distinctly unpleasant one!

Those biologists who are undismayed by formidable formulæ, and who have not as yet studied wave-movements of water from the mathematical point of view, will find the greater part of the problem treated mathematically by Lamb (1) and Basset (2); but I will assume that the Senior Wrangler was right, and that the biologist is a man of observation rather than of mathematical investigation, and I will, therefore, appeal rather to his power of observing than to his mathematical faculty.

It is unfortunate that at times in our dredging excursions, when the waves are largest and best fitted for study, those of us who lean

over the side of the boat are usually not in the best possible condition for making scientific observations. The end of a pier has, however, some advantages over a boat under way; but in a boat at anchor is the place where the observations can best be made. The best time for the purpose is when the waves are large, and especially when their crests are sharp-edged and not rounded, and when there is no wind and no breakers or "white horses." Most of the points, however, may be made out from the pier-head, though in that case the path of the particle or of the mass is not a circle, as in deep water, but an ellipse with the long axis horizontal.

A *small* floating body almost or completely submerged is not carried along with the waves, but moves when on the crest of a wave more slowly than the wave, but in the same direction. So soon as it has fallen behind the crest into the trough it moves in the opposite direction as if, having slipped off one crest, it were hurrying to climb up to the summit of the next one. In the open sea the extent of this to-and-fro movement is equal to that of the up-and-down movement, so that the body—provided it be *very* small—constantly travels in a circular orbit, the diameter of which is equal to the height of the crests above the troughs. If there be no wind it will hardly progress at all, but will return always to almost the same place. The very slight progress of particles near the surface may be neglected, and the path of each particle may be regarded as a circle.

Let us now suppose the water divided into a series of layers, which, if the water were at rest, would each have a uniform thickness of, say, one inch. The passage of waves would not cause the water of one layer to mix with that of others; but since the water of the superficial layer in a trough is moving in the opposite direction to that in the crest behind it, it follows that the length of the portion between these two points, measured in the direction in which the waves are travelling, is getting less, and this portion of the layer must therefore be getting thicker, while the portion on the back of the wave is getting thinner. The total amount of the elevation of the crest is the net result, the sum, of the thickenings of all the successive layers of water, from the surface down to the bottom. The depression in the trough is similarly the net result of the thinning of all the layers below this region.

Another mode of observation is even more instructive. A *small* loose tangle of zoophytes, or of fine seaweed, or a very loose ball of tow, thrown into the water, is seen to rise and fall and to move to and fro; but though each part of it describes a circle, the mass does not rotate, nor yet do its parts move all together. One part of the mass is at the top of its circular orbit before another, and hence the mass changes in form. The changes of form, or deformations, may be most easily described if we suppose the mass to be such that in still water it would be spherical, that is, a sphere of water rendered visible by the suspension within it of loose tow or seaweed, or, better still,

mud-particles. When the water is disturbed by the passage of waves, the sphere becomes an ellipsoid, but it *does not mix* with the surrounding water. The longest axis of the ellipsoid is vertical when the mass is under (or within) the crest of a wave, and its shortest axis is horizontal and parallel to the direction in which the waves are travelling —this direction we will call longitudinal. The transverse axis of the ellipsoid, that is, the axis parallel to the crest of the wave, remains unchanged throughout, and therefore equal to the diameter of the spherical mass we started with. As this remains unaltered, we may leave it out from further consideration.

As the mass we are considering falls into the trough behind, that is, as the wave recedes from it, it comes to be elongated in a series of new directions. At first sight, the mass appears to rotate in the direction in which each of its parts revolves, so that the upper end of the long axis comes to be inclined forwards till when the bottom of the trough is reached this long axis is horizontal and longitudinal. The mass, however, does not really rotate : the point which was uppermost when the mass was at the crest of the wave is uppermost still when in the trough. The *form* of the ellipsoid rotates, while its substance does not. The long axis is vertical every time the mass is at the crest of a wave. In passing from one wave-crest to the next the *form* (not the substance) rotates through *half a revolution*. During the same period each particle performs a *complete circular* journey. The relative movement of any two particles in the mass is one of oscillation. Take, for instance, the uppermost and the lowermost particles of the spherical mass with which we started. When the water is still, one is vertically above the other. During the movement the upper one (A) moves in a circle, and the lower one (B) moves in a smaller circle. A is therefore above B when both are under the crest, and again when both are under the bottom of the trough. At every moment A and B are moving in the same direction, but A always faster than B. At the crest both are moving forwards, A therefore comes to be slightly in front of B, but as both turn to move backwards, A comes to be above B again in the trough and then comes to be behind it. If we take two other particles a similar result is reached, but with a difference. If the two particles are not in the same vertical transverse plane when at rest, then they will not at any moment be moving in the same direction. Suppose C and D be particles at the two ends of the "longitudinal" diameter of the sphere in still water, C being in front, D behind. Then as the waves advance D will always move somewhat before C, so that when the middle of the mass is under the crest D will already have begun to move downwards, while C is still moving upwards. At this stage C and D will also be nearer together than at any other. In the trough these will be further apart than at any other stage, and while both are moving backwards D will already be moving backwards and upwards, while C is still moving backwards and downwards.

The diameter of the circular orbit of a particle at the surface is equal to the height of the crests above the troughs, as has already been seen. The point which is of most importance to the jelly-fish, however, is the amount of movement and of deformation at various depths below the surface. This has been investigated by mathematicians, who express the result as follows :—Calling the diameter of the circular path of any particle the " extent " of its movement, and writing $a$ for the extent of movement of a superficial particle, that is, for the height of the crests above the troughs, and $\lambda$ for the distance between one crest and the next, then a particle which in the undisturbed water is at a distance $h$ below the surface will in the disturbed water move to the extent expressed in the formula $ae^{-\frac{2\pi h}{\lambda}}$

At a quarter of a wave-length from the surface $4h = \lambda$, and the extent becomes $ae^{-\frac{\pi}{2}} = \frac{a}{5}$ or one-fifth of extent of movement at the surface. At half a wave-length below the surface $2h = \lambda$, and the extent, therefore, $ae^{-\pi} =$ one twenty-third of $a$. At one wave-length the extent is $ae^{-2\pi} = \frac{1}{535}$ of $a$. (The calculations are only rough approximations.)

From this it is obvious that, however violent the movement may be at the surface, there is always a zone to be found not far from the surface where the jelly-fish may swim and feed in safety, but above which it would be exposed to danger from the violence of the movements of the water. This zone we will call the " zone of safety," but it appears probable that the name " zone of maximum food-supply " would be equally appropriate. Its depth below the surface varies with the violence of the movements at the surface. In still water it is at the surface.

I have now to show reason for the belief that the tentaculocysts, without giving rise to any sensation, can automatically steer the jelly-fish in such way as to keep it close to this zone and to bring it back to this zone whenever it is forcibly carried away from it (as by currents), and that this will happen, whatever the distance of this zone below the surface may be.

Before considering how the tentaculocysts can serve this important function, I would once more remind my readers that the only waves we have been considering are waves—not breakers or " white horses "—in the deep ocean, and not in shallow water.

Suppose the jelly-fish to be some distance below this zone of safety and in water in which there is no appreciable disturbance, it will then, by virtue of the greater specific gravity of its oral portion, float with the mouth downward. Its rhythmic contraction will, under these circumstances, by increasing the mutual pressure between the water in the sub-umbrellar space and the inner surface of the umbrella, cause the animal to move upwards till it reaches a zone

where the movement of the water is great enough to tilt the animal into an oblique position.

In what zone this will happen depends upon conditions too complex for consideration here, but the direction in which the tilting will occur is a matter worth considering, and one which presents no great difficulty.

Each layer of water becomes thinner when under a trough of the surface-wave, and thicker when under a crest. The ratio of the velocities of two layers is constant so long as the surface disturbance remains unchanged. Hence it is obvious that as the jelly-fish extends through more layers when under a trough (where the layers are thinnest) than when under a crest, the difference in the rates of movement of the uppermost and lowermost of the layers occupied by the jelly-fish is greatest when under the trough, that is, when the movement is opposite in direction to that of the waves. Hence the alternate tilts in opposite directions will not be equal, and the total effect will be that the animal is turned with its aboral (or "upper") surface "up-storm," that is, towards the direction from which the waves are coming.

The rhythmic contractions continuing, the animal will swim upwards and in a direction opposite to that of the waves. As it does so it comes into new zones, each moving more rapidly than the previous ones, till at length a zone is reached where the changes in velocity are so great that the slight elasticity of the stalk of the tentaculocyst is no longer sufficient to keep the weighted tip from lagging so far behind the pouch as to touch its walls. At the moment when it touches, a stimulus is produced, which causes a more energetic contraction of the bell, especially in the adjacent portion of the bell. The tentaculocysts first so affected will, of course, be those exposed to most rapid changes of velocity, that is, those in the edge which is turned upwards. The vigorous contraction of this portion of the bell in advance of the contraction of the rest will turn the animal, with its aboral face, first, directly towards the point of the compass from which the waves proceed, and then gradually downwards, the swimming movements taking the animal to a greater depth, and in the direction opposite to that in which the waves travel.

When a deeper zone is reached, where the movement is too slight to bring the lithite, or weighted end of the tentacular portion of the tentaculocyst, into contact with the sides of the pouch, the greater specific gravity of the oral portion of the animal again turns the aboral surface somewhat upwards, and the animal again approaches the surface.

The animal is thus automatically steered so as to be kept always in the uppermost zone of safety—a zone of maximum food-supply; and this explanation involves no assumption as to consciousness, or sensation, or judgment on the part of the jelly-fish.

A pelagic mollusc, such as *Pterotrachea*, has a pair of "otocysts"

in close relation with a large nerve ganglion, or rather pair of nerve ganglia, with which the eyes and tentacles are also connected. The organisation of the mollusc is, moreover, incomparably higher than that of the jelly-fish, and it is not very rash to suppose that in this case the shaking of the animal by the movement of the water, and the consequent collision of the walls of the "otocyst" with the lithite ("otolith") gives rise to a sensation. Whether it does so or not is, however, of little moment. The ganglia are connected (indirectly) with muscles, and the stimulus produced by the collision of lithite and otocyst-wall may safely be assumed to lead to muscular movements, either reflex or voluntary—movement which will take the animal to safer zones of water.

A shaking of the "auditory sac" of a crustacean would, by jolting the "auditory" hairs against the lithites—mere sand particles—produce a stimulus. The shaking might be produced in either of two ways: it might arise from a tremor of the ground upon which, or in which, the animal is resting, or from a disturbance of the water about the flagella of the antennule. Of the advantage of being thus warned of the approach of an animal which either may serve as food for the crustacean, or might feed upon it if it were taken unawares, there need be no doubt.

REFERENCES.

1. **Lamb, H.**—"A Treatise on the Mathematical Theory of the Motion of Fluids." Cambridge, 1879.
2. **Basset, A. B.**—"A Treatise on Hydrodynamics." Cambridge, 1888.
3. **Romanes, G. J.**—"Jelly-Fish, Star-Fish, and Sea-Urchins." London, 1885.

C. Herbert Hurst.

A CORRECTION:—

In the previous article in this series (p. 352, 19 lines from the bottom), for "500 miles" *read* "500,000 miles."

## III.

# Naegeli's Experiments on Living Cells.

A SHORT notice of Carl von Nägeli's paper, "Über oligodynamische Erscheinungen in lebenden zellen," concerning the fatal effect of "nominally" pure water on living cells, appeared in NATURAL SCIENCE (May, p. 333). The following is an account of the experiments by which Nägeli arrived at his conclusions. The record of this work, which was carried on in his laboratory at Munich, was found by Schwendener among his papers after his death. Professor Cramer, of Zürich, went carefully over the ground a second time and obtained the same results as his old master.

The research, we are told by Schwendener, dates from the year 1880. Dr. O. Löw and Dr. Bokorny had recently published a paper on the reduction of silver salts by living protoplasm. While verifying for himself the results arrived at by these gentlemen, Nägeli was led to turn his attention from the effect of living cells upon silver salts to the reverse action of the silver salts on living cells.

The *Spirogyra* experimented on is a very common fresh-water Alga; it is composed of long cylindrical filaments, divided up at regular short intervals into cells, with spiral parietal bands of chlorophyll. The spirals may be single or double, and they, as well as the cells, vary in size in the different species. These differences affected, to a considerable extent, the sensitiveness of the plant under examination; the more compact the spirals the greater the resisting power of the cells. It was also found that resistance to any hurtful influence was at its maximum towards the close of the day, when there was a great accumulation of assimilation products in the chlorophyll bands. In the early morning, when these were withdrawn and dispersed through the cells, the plant was much more sensitive.

The alkaline solution of the silver salt used by Nägeli in his experiment was the one prepared by Dr. Löw (containing 1 Ag $NO_3$, 1 $NH_3$, 3·6 $K_2O$ to 100,000 volumes of water), which killed the plant by poisoning it; the cells lost their turgidity, the protoplasmic layer shrunk away from the walls, the chlorophyll bands changed colour and gradually became disintegrated. With further dilution the cells still died, but in a totally different manner; the turgidity of the cells and the protoplasmic layer remained unaffected, the chlorophyll bands alone seemed to be sensitive, they shrunk together with the

nucleus into a round ball. To this latter result Nägeli gave at first the name *Isagität*, but later he changed it to *Oligodynamic*.

As to the effect of solutions generally on *Spirogyra* and other cells, Nägeli enumerates three ways in which they may prove fatal—physically, by inducing plasmolysis, for instance; chemically, by poisoning the plant; and lastly, oligodynamically. The last-mentioned resulted when the chemical solution was so diluted that the reaction could not be one of simple poisoning, but must be due to some other influence.

Nägeli pursued the research still on the same lines; he put the filaments into Dr. Löw's solution, diluted quadrillion-fold, till, finally, he concluded that no calculable trace of the poisonous silver nitrate was present; the result was equally satisfactory from an oligodynamic point of view, the cells died often in less than four minutes. He now turned his attention to the water used in the solution, which was distilled in the ordinary way, and the conclusion arrived at was a startling one, namely, that pure water is a dangerous and hurtful fluid. After boiling, the evil effects diminished, they did not quite disappear.

Another series of experiments was tried with mercuric chloride—a still stronger poison. This was diluted down to septillion-fold, and the plants died as before. Professor Cramer has calculated that in order to dilute 1 milligramme of mercuric chloride to this extent, we should require more water than there is on our planet. A globe of water would be necessary thirteen million geographical miles in diameter, which would reach almost from the sun to Venus, and the molecules in such a solution would be separated from each other by a distance equal to two-thirds of the earth's diameter. He concluded, as we do, that the solution would be harmless, so far as mercuric chloride was concerned. This experiment proved conclusively that the evil was due to something other than chemical poison.

Attention was next turned to the glass vessels used, to see if the effect was produced by mechanical action. The glasses were tested in various ways, by movement, by covering them, etc., but no difference was visible in the behaviour of the solution; the *Spirogyra* died, and yet not always; in four out of this series of experiments the *Spirogyra* remained uninjured in the diluted solution. Again, boiling was tried, and in most cases the water was restored—we can hardly say to purity, but to harmlessness, or, as Nägeli terms it, it was rendered neutral.

Meanwhile, control experiments with pure distilled water had been carried on quite successfully in glasses full of *Spirogyra*. A culture was now tried with the same water and only a few filaments; as Nägeli expected, they died, if anything, still more quickly than in the diluted chemical solution, and water from the tap acted frequently exactly like distilled water.

A further research was now entered on to test the water, and as distilled water was, on the whole, more fatal than tap-water, he

fancied the poison might be a gas absorbed in the water and passing over in distillation. Carbonic acid, ammonia, and ozone were ruled out of the question, as any water in which Algæ live necessarily contains these gases in greater or less quantity, and such water, from spring or river, pool or pond, was found to be harmless. Moreover, when these gases were added to the cultures no effect followed. There remained nitrous acid to be suspected, and the more so that Munich water was said to contain a good deal of this acid which would not be eliminated by distillation. A solution was made containing potassium nitrite and sulphuric acid, which would liberate free acid in the distilled water. The same results followed as before, namely, chemical poisoning in the stronger solution, and the oligodynamic effect when much diluted. Griess's test was applied to estimate the quantity of nitrous acid in the ordinary water and in distilled water, but only once was there any reaction, and that so slight that no possible harm could be done by the amount present.

Very remarkable results in rendering water oligodynamic were obtained by treating it with various bodies considered practically insoluble in ordinary water. These were copper, silver, lead, iron, tin, and quicksilver. A whole series of experiments was tried with well-cleaned coins. Thus glass vessels, containing 100 or 500 cubic centimetres of water, were arranged with one, two, four, and eight gold coins. In these glasses were placed equal quantities of *Spirogyra* filaments. The plants in the glasses with the largest number of coins died first, the others succumbed more slowly, while the same species of *Spirogyra* lived in a healthy condition for weeks in ordinary spring water.

Again, the effect was tried with neutral water in metallic vessels of silver and platinum; the *Spirogyra* filaments died as before, and if copper coins were dropped in a glass containing the filaments the effect was so far localised that those nearest the coins were attacked first.

Nägeli had thus found an easy method of rendering water oligodynamic. A step further, and he made the still more remarkable discovery that he could again render the solutions neutral by the addition of quite insoluble bodies, trying first sulphur, soot, or graphite, then manganese, starch, flour, cellulose (filter-paper, cotton, linen, or wood), silk, wool, stearin, paraffin, etc., and the more of these bodies he put in, the quicker did the water recover its neutrality. He found that Algæ themselves would act in the same way if he put in plenty of them; they, too, had power to render the water neutral. This enabled him to account for much that had been hitherto inexplicable in the control experiments, where no proportion had been observed between the relative quantities of Algæ and water. This was put definitely to the proof, and it was found that the more water used, and the fewer the filaments, so much the quicker did oligodynamic reaction take place. Colloid substances, such as gum,

dextrin, albumen, glue, were also successfully employed as neutralising agents; while sugar and salt, which dissolved in the water, were almost wholly ineffective.

Results were for a time much confused by the persistence of after-effects in the vessels. The glasses in which coins had been immersed retained, to some degree, oligodynamic power, even after careful cleansing, and the effect continued, all unknown to the experimenters, during three or four subsequent cultures.

Nägeli had now arrived at what seemed to be a deadlock; that almost insoluble substances should exert so fatal a power, and that quite insoluble substances should be effective in counteracting it, was very mysterious.

Would electricity, or some such imponderable agent, he asked, account for the facts? And so there were started new experiments to put this theory to the test.

The first bore upon Temperature; but here again he was baffled, as neither excessive heat nor sudden change accounted for the hidden force.

The effect of Light was questioned, and that also gave no response.

There remained Electricity. Had it been generated in the water by the metals employed, and did *Spirogyra* cells act as an electroscope, exceeding anything hitherto known in sensitiveness? This theory also was found untenable. Vessels of water were separately charged with positive and negative electricity, and the plants were put in. They remained unaffected, and equally so when a strong induction current of electricity was passed through a tube in which filaments had been placed. The plants were further exposed to the direct action of electricity from a battery; this caused the cells to swell, and induced other changes, but it in nowise resembled the action of oligodynamics.

The only conclusion left was that here was a new power not to be accounted for by any present theories; either a new agent was at work, or the old agents had developed new properties.

The problem was attacked again, to see if the metals abovementioned acted in solution or in mass. Gold and platinum are quite insoluble; they had already been tested, but the gold coins used were alloyed with copper. Pure gold was prepared from gold chloride, and the platinum was treated with hydrochloric acid; they were then found to be harmless, and also it was now proved that washing with acid would neutralise oligodynamic glasses. Thus it was, in all probability, some barely soluble substance, such as copper, that had to be dealt with.

Oligodynamic water was analysed, and was found to contain lead, zinc, copper, and iron. Some copper coins were left for a stated time in water till it became strongly oligodynamic. On analysis, the solution yielded one volume of copper to seventy-seven million volumes of water.

Twelve pennies were left four days in twelve litres of water, which then had a slightly metallic taste, and the *Spirogyra* plant died in it in one minute. The water generally used in experiment had been only one-fifth or one-tenth so strongly oligodynamic. Indeed, one part of copper in one thousand million parts of water may be fatal to *Spirogyra* cells. The copper went into solution as cupric hydrate combined with carbonic acid. Other metals, silver, zinc, iron, lead, mercury, acted similarly. The salts of these metals could also render water oligodynamic, and the vessels that had contained the solutions retained oligodynamic power, though to a less marked extent.

According to physicists, the saturation of a solution depends on the quantity of substance that a definite quantity of water will take up; as the solution becomes supersaturated, equilibrium is restored by the redeposition of the substance. The molecules of a barely soluble body tend to attach themselves to some other substance, and so pass out of solution. Thus copper, in water which contains carbonic or other acid, gives off its molecules slowly but continuously. These spread through the water, some attaching themselves to the wall of the vessel. As complete saturation is reached, still more molecules adhere to the walls. Should the copper be removed before this stage is reached, the water withdraws some of the molecules from the wall and an equilibrium is established between the copper layer and the solution. If such a solution be poured into a clean glass, a layer of copper molecules is again deposited, and the greater area of wall offered, the more molecules will be attracted from the solution.

In this lies the explanation of the neutralising effect of the various bodies above-mentioned. They simply attracted the metallic molecules. When oligodynamic water was well shaken up with powdered sulphur, and filtered, it was rendered completely neutral, and thus also sugar or salt failed, as they themselves pass readily into solution.

As to the action of gum, albumen, etc., Nägeli explains it on his own "micellar" theory of the structure of organised bodies, of the truth of which he finds here additional evidence. He considers that organised bodies are built up of micellæ, invisible crystalline bodies, formed by the aggregation of chemical molecules, and that colloid substances form with water "micellar solutions"; the copper molecules attached themselves to the micellæ as they would to larger bodies. The Algæ themselves acted as neutralising agents when their number was in excess, and in this case the molecules could only act very slowly or not at all.

Metallic substances would, in the same way, be removed from lakes, rivers, etc., by the presence of large quantities of insoluble substances.

The water used in the experiment was supplied by the town (Munich). It was conducted through lead pipes terminating in the

laboratory in a brass tap. The first litres drawn were strongly oligodynamic, from contact with the lead and with the copper of the tap; after some quantity had been run off, the water was neutral. The distilled water was rendered hurtful by the apparatus used. Neutral water could be obtained at any time by distilling in glass alone.

Nägeli's papers on oligodynamics were handed to Professor Cramer of Zürich in the spring of 1892, who at once instituted a careful examination of the recorded experiments, with the result that this peculiar power of weak metallic solutions was completely verified. He followed very much on the lines of the previous research, testing the effect on *Spirogyra* cells of copper, copper sulphate, mercury, mercuric chloride, and Dr. Löw's solution of alkaline silver nitrate, and the results, with slight variations, corresponded to those already determined by Nägeli.

The water used in Zürich comes from the lake, is exceptionally pure, and is conveyed to the town in iron pipes. With the exception of the first litre drawn, which had been in contact with the brass tap of the laboratory, it was, in Nägeli's sense, absolutely neutral. The distilled water usually employed was prepared in a copper vessel lined with tin. It reacted variously, and especially seemed to lose oligodynamic power if it had been in several vessels, or if it had stood some time after preparation. In this connection, we may also note that he found the oligodynamic reaction was in proportion to the size of the vessel used in experiments. If there was much of the metallic solution in a small vessel, the effect on the cells was rapid; the same solution acted much more slowly when a drop of it was used on a glass slide where the glass surface exposed was so much greater in proportion to the quantity of metallic molecules present. The solution became weaker the longer it was allowed to stand, and repeated boiling or filtering neutralised it altogether. Water distilled in glass was, he also found, invariably neutral.

Professor Cramer chose, for the purpose of research, three species of *Spirogyra*; one of these, *Sp. quinina*, is of a delicate texture with only one spiral chlorophyll band, the other two, *Sp. densa* and *Sp. setiformis*, are coarser. The reaction depended, to a certain extent, on the species; *Sp. setiformis*, with closely-wound spirals, always resisted the action of the metal longer than the other two species. The sensitiveness of the plant was, however, intensified if it had been long under cultivation in the warm temperature of the laboratory, in which case the cells lengthened, and the spirals were, in consequence, looser and more sparse. He used for his control cultures large glass vessels filled with ordinary Zürich water.

Oligodynamic reaction was most easily obtained by water in which copper had remained from one to three days. If a healthy plant growing in neutral water were strewn with copper turnings, the chlorophyll bands very quickly shrunk from the sides of the cells in contact with the copper. A glass slide that had been in contact

with the moist copper stage of the microscope proved strongly oligodynamic after an interval of sixteen days.

Professor Cramer directed his attention chiefly to the action of copper and mercury upon water; he obtained them chemically pure, and placed them in vessels, some of which were carefully stoppered and full to the brim with neutral distilled water, others were only half full, and were supplied with oxygen and carbonic acid. The water in both cases became oligodynamic, the latter more powerfully; but though, in the former, the air had been carefully excluded, the water gave an acid reaction. Zürich water, which was chemically neutral, contained very little chalk, but there was enough to cause discolouration, as the carbonic acid, which had held the lime in solution, was set free and passed over with distillation. Besides this acid, Professor Cramer thinks there might be traces of silicic acid present.

In addition to the neutralising agents enumerated by Nägeli, it was found that iron rust was very effective, as also *Leptothrix ochracea*, an Alga belonging to the Schizophytæ rich in ferric hydrate.

With the various solutions the same effects were produced as already recorded; first that of chemical poisoning in the cells when much of the deleterious agent was present, followed by the equally fatal oligodynamic reaction in diluted solutions. At a certain stage of dilution, if neutral water were employed, all reaction ceased.

Annie Lorrain Smith.

# IV.

## Some Extinct Sharks and Ganoid Fishes.[1]

OUR conceptions of some of the more primitive groups of fishes have been greatly modified during the past few years. The discovery of nearly complete skeletons has shown that the fragmentary fossils originally compared with the corresponding hard parts of existing animals truly belong to strange races of which no idea could be formed from their examination alone. Sharks, sturgeons, mud-fishes, and the fringe-finned ganoids, in Palæozoic times seem to have flourished under almost as many modifications as characterise the modern bony fishes in the fauna of to-day; and it becomes more and more evident, as discoveries continue, that the common ancestors of the class date back to a period hopelessly remote, so far as the palæontologist is concerned.

Among those who have contributed an important share to the formation of these new conceptions, Dr. Anton Fritsch, of Prague, merits our special gratitude. He has for many years collected the fossil vertebrata from the Permian gas-coal formation of Bohemia, even preserving the pyritised specimens by removing the decayed bone and taking electrotypes of the impressions; and his great work descriptive of these fossils is the most painstaking and elaborately illustrated monograph of its kind. Quite lately, a new instalment of the third volume has appeared, and the account of the fishes is now extended to include the Acanthodians and the first section of the Palæoniscids.

Several years ago, in an earlier section of his work, Dr. Fritsch published the first detailed description of the singular primitive sharks known as the Ichthyotomi, supplementing the beautiful figures and brief notes of M. Charles Brongniart in his monograph on similar fossils from the French Coal-measures. Now, he adds further to our knowledge of the sharks by a detailed chapter on the Acanthodians; though in this case, unfortunately, he is able to contribute comparatively few new facts of fundamental importance, merely confirming, revising, and systematising the observations of previous authors.

[1] FAUNA DER GASKOHLE UND DER KALKSTEINE DER PERM-FORMATION BOHMENS. Vol. iii., pt. 2. By Professor Anton Fritsch Prague: F. Rivnac, 1893.

The Acanthodian fishes, discovered in Palæozoic rocks from the Lower Devonian upwards, have always presented difficulties to systematists; but it is now generally agreed that they are a peculiar order of sharks. As to the precise significance of several parts of their skeleton, however, there is still much disagreement, and Dr. Fritsch himself wisely refrains from very definite expressions of opinion.

The general aspect of the type-genus *Acanthodes* is shown in Dr. Fritsch's outline figure reproduced below. The cartilages of the head are calcified with granulations, as in sharks; and there are splints covering the jaws, but neither these nor any other skeletal parts have the structure of bone. The roof of the skull is covered at least in part with small dermal plates, and there is a ring of plates round the eye. The gill-arches are so much crowded that Dr. Fritsch thinks the gill-slits must have been covered by a flap of skin, as in the existing Chimæroids. The notochord must have been persistent, and there are rarely traces of the neural and hæmal arches above and below the vacant space it once occupied. The tail is heterocercal,

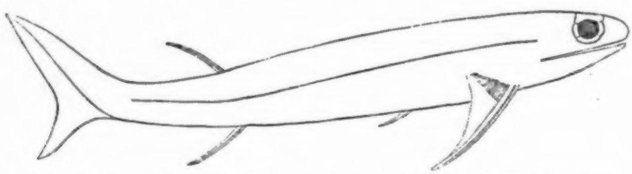


FIG. 1.—Outline restoration of *Acanthodes bronni*; Permian, Rhenish Prussia. (*After* Fritsch.)

the upper lobe being much produced; and in front of all the fins, except the caudal, there is a strong spine. The body is covered with little quadrangular scales, consisting of dentine enamelled at the surface; and the "lateral line" does not pierce these scales, but runs between two series.

Among the Permian Acanthodians Dr. Fritsch recognises three genera, one of which is destitute of pelvic fins. The large size of the paired fins, however, is one of the chief characteristics of *Acanthodes* itself; and, as pointed out by Professor Cope, there is more evidence of a continuous pair of lateral fin-folds in these Acanthodians than in any other fishes. Some of the Devonian genera (*e.g.*, *Climatius*), exhibit between the pectoral and pelvic fins a close and regular series of paired spines, in every respect identical with those supporting the fins themselves; and it is quite possible that these intermediate spines may also have been connected with fin-membrane.

It is strange to find a group of fishes like the Acanthodians among the sharks—fishes which at the present day never exhibit structures of the nature of membrane-bones, and never have the

cartilages of their limbs excessively abbreviated. It is, however, stranger still to have to regard the Palæoniscidæ as primitive representatives of the modern sturgeons; and yet Dr. Fritsch, following all who have deeply studied the subject, is fully convinced of the necessity of this course. He describes the genus *Trissolepis*, giving the restoration copied below; and this he regards as the type of a distinct family to be placed in the same sub-order as *Palæoniscus* itself.

The Palæoniscidæ, as a general rule, conform to the type shown in Fig. 2; being essentially sturgeons (as Dr. Traquair first pointed out) covered with regular rhombic scales and provided with a complete

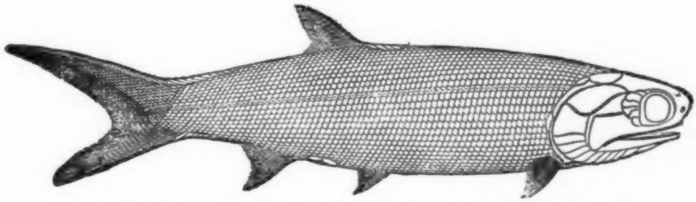


FIG. 2.—Restoration of *Palæoniscus macropomus*; Permian, Germany. (*After* Traquair.)

gill-covering apparatus. In some cases, however, the scales disappear except on the upper lobe of the tail; and in a single instance, briefly noticed by Dr. Traquair, the scales become deeply overlapping and almost or quite cycloidal.

Now, the great interest of Dr. Fritsch's new contribution to the subject consists in the fact that it is the first detailed and illustrated account of one of these ancestral sturgeons possessing cycloidal scales. Moreover, it is to be noted that in *Trissolepis* the cycloidal scales are confined to the trunk, while the rhombic scales persist on the upper lobe of the tail. One and the same fish thus displays

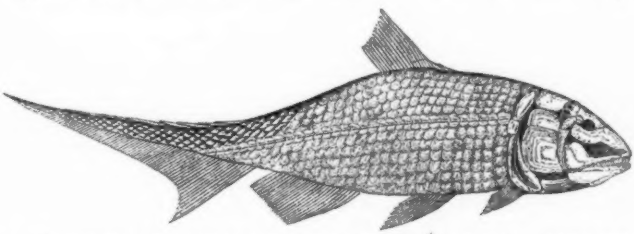


FIG. 3.—Restoration of *Trissolepis kounoviensis*; Permian, Bohemia. (*After* Fritsch.)

features which were not long ago regarded as the essential characters of distinct groups; and the shape of the scales in future must only be cited among the minor diagnostic points of the old "ganoid" fishes. We are acquainted with Jurassic fishes, indeed, in which the anterior scales are rhombic, ribbed, and united by peg-and-socket joints,

while the scales on the tail of the same fish are as thin and deeply overlapping as in a herring.

In a general review it does not seem appropriate to enter more closely into the details of Dr. Fritsch's work; Dr. Traquair has already published a critical notice in the *Geological Magazine* (dec. iii., vol. x., pp. 175–178). We would, however, urge all who are interested in Comparative Anatomy to study the original for themselves.

A. Smith Woodward.

V.

# Notes on Warning and Protective Colour in Lepidopterous Larvæ.

IN the April number of NATURAL SCIENCE, Mr. George Carpenter deals with the vexed question of "Colour in Insects." The whole subject of animal colouration has been much debated, and as it is only by means of a long series of careful experiments and close observation that we can hope to arrive at any clear understanding of it, every particle of evidence, however small, may have some value. From this point of view the following notes may not be without interest.

The experiments made by me as to palatability and colour-relation in lepidopterous larvæ were, as Mr. Carpenter correctly states, entirely confirmatory of those previously conducted by Mr. Poulton and others. They have been recorded in detail elsewhere (*Trans. Ent. Soc. Lond.*, 1892, pt. iii.), and I therefore give only a brief sketch of them here, together with a few additional facts which have come under my notice since writing the above-mentioned paper. Experiments as to the palatability of conspicuous larvæ were made with four species, viz., with larvæ of *Diloba caeruleocephala*, *Cucullia verbasci*, *Acronycta psi*, and *Bombyx rubi*. Larvæ of the two first-named species were given to a tame jackdaw, which had been taken unfledged the previous year, and could never have seen any larvæ except those I gave him, unless some had dropped occasionally from a beech tree which overhung his cage. The larvæ of *D. caeruleocephala* were taken feeding freely exposed on pear trees; they were blue, yellow, and black, very conspicuous, and not hairy.

The bird was accustomed to take anything from my hand, and would always seize and attempt to pull to pieces any object presented to him, whether he was hungry or not; he was, therefore, a good subject for experiment.

On offering him a larva he appeared very suspicious, and for a long time would not take it. Then he tasted it, but dropped it at once, shaking his head violently, and evidently disliking it. It was tasted once more, and then left uneaten. The next day he was offered a common smooth green larva (species unknown) and ate it without hesitation. He was not very hungry on either occasion.

Larvæ of *C. verbasci* were taken feeding exposed on the upper side of leaves of mullein; they were green, yellow, and black, very conspicuous, and not hairy. One was offered to the jackdaw when the bird was very hungry; it was refused at first, then tasted once only, and dropped with greater signs of disgust than in the case of *D. caeruleocephala*. After this he would not take anything at all from me for a considerable time, and appeared very uncomfortable.

In the case of *Acronycta psi* and *Bombyx rubi* the animals experimented on were three slowworms (*Anguis fragilis*) and one lizard (*Zootoca vivipara*). These were purposely kept very hungry, but though the larvæ were left with them for three days they refused them entirely, never even attempting to taste them. Both these larvæ, however, were hairy as well as conspicuous, and, therefore—assuming that conspicuousness means unpalatability—were doubly protected. The fact that an animal may possess more than one kind of protection must of course be taken into account in making these experiments, and for this reason the experiments with *D. caeruleocephala* and *C. verbasci* were the most satisfactory, because here the unpleasant attitude was almost certainly taste only. Mr. Poulton says (*Proc. Zool. Soc. Lond.*, March 1, 1887) that Mr. Jenner Weir found the two last-named larvæ to be disregarded both by birds and lizards. This certainly supports Professor Wallace's original suggestion of the unpalatability of conspicuous larvæ to "some, at least, of their enemies," while, on the other hand, the results obtained by me also favoured Mr. Poulton's suggestion as to hunger putting a limit to this method of defence, since the larvæ were tasted, and tasting would be as fatal to them as eating.

Mr. Beddard ("Animal Colouration," p. 164) found that *A. psi* was eaten by *Lacerta viridis*, and at least tasted by a thrush, but he does not mention whether either was hungry on these occasions, a point of some importance. In any case, his results differed from mine in this experiment, but then a different species of lizard was used. *L. viridis* would seem, from other experiments of Mr. Beddard's, to be less sensitive to unpleasant attributes than other lizards, *Z. vivipara*, for instance. This difference of behaviour does, as Mr. Beddard points out (*loc. cit.*, p. 155), show that unpalatable animals with warning colours are not always exempt from attack, but this very fact rather tends to support the view held by Mr. Poulton that this means of defence can only safely be adopted by a limited number. On the other hand, it militates strongly against Dr. Eirig's theory, quoted by Mr. Beddard, that brilliant colours (*i.e.*, abundant secretion of pigment) are the cause of inedibility. Exceptional cases like that of *L. viridis* eating *Acronycta psi* are difficult to explain on this hypothesis, but they appear more comprehensible on the theory of limitation. *A. psi* might be regarded as one of the few examples of the failure as a means of defence both of the unpleasant attribute and its advertising warning colours, and *L. viridis* as having had its power of

eating this larva with impunity developed by the action of Natural Selection, after necessity had first driven its ancestors to the attempt.

My experiments were made on a less extensive scale than those described by Mr. Beddard as undertaken by Mr. Finn and himself, and are, therefore, perhaps, of less value; but as far as my experience went I was not at all able to confirm Mr. Beddard's statements as to the "behaviour of animals when offered inconspicuously-coloured" prey, resembling that with which they approached conspicuous forms. I repeatedly gave common green smooth larvæ and other species with protective colouration both to the bird and lizards, and invariably found them accepted and eaten without the slightest hesitation, except just after distasteful food. I scarcely think the garden slug, which Mr. Beddard saw refused by several birds, is a fair example of a protectively-coloured animal treated as if it were inedible. The slime of the slug would be disliked by many animals, and there is evidence from many of the experiments that it was so disliked, since it was only swallowed "after much rubbing on the ground." The slime would seem to be as effectual a protection, apart from all question of colour, against some pursuers as the hairs of the larva of *Bombyx rubi*; the latter cannot be said to be conspicuously-coloured, and yet was refused by all the animals with which I experimented. I did not find a single case of a larva which was both protectively-coloured *and smooth* being refused by animals; such larvæ were always eaten with avidity. It will, however, be interesting to extend these experiments and note the results carefully, and it is one of the great merits of Mr. Beddard's book that he therein points out so many lines for investigation, and calls attention to many details which are worthy of further consideration.

With regard to experiments on the colour-relation between certain lepidopterous larvæ and their surroundings, the results obtained by me were the same as those obtained by Mr. Poulton previously with the same species, except that in one case my results were, perhaps, slightly more definite.

I reared in different surroundings 19 larvæ of *Rumia cratoegata*, 42 larvæ of *Catocala nupta*, 10 larvæ of *Catocala fraxini*, and 29 ot *Mamestra brassicæ*. Dark surroundings produced in *R. cratoegata* very dark brown or nearly black larvæ, while in green surroundings larvæ from the same parent became of varying shades of green or greenish-brown, with touches of crimson exactly corresponding to the red of the thorns and one side of the young shoots of the food-plant. The resemblance to twigs of hawthorn was very perfect, and was heightened by the angular attitude adopted by the larvæ at rest.

For *Catocala nupta*, dark, green, and white surroundings were used, and the dark surroundings produced darker brown larvæ than the green surroundings, while no difference in shade was perceptible between those in green and those in white surroundings. Mr. Poulton

considers (*Trans. Ent. Soc. Lond.*, 1892, pt. iv.) this species to be less susceptible than other Catocalidæ.

*Catocala fraxini* certainly showed a distinct difference, not only of shade, but of colour, larvæ reared in green surroundings being distinctly greenish in hue, while those in dark were brownish. Mr. Poulton obtained only a difference in shade, otherwise his results were similar.

With *Mamestra brassicæ* I had negative results; the larvæ were not affected at all by surroundings, and I believe this unsusceptibility to be due to the burying habits of this species, which render colour of secondary importance to the larvæ. Mr. Poulton's results differed a little from mine, but he thought that his larvæ were not in such a healthy condition as mine, which might account for this. There are, however, special difficulties in investigating *M. brassicæ*, and Mr. Poulton considers the experiment worth repeating.

Since publishing these results, I made some experiments, at Mr. Poulton's suggestion, on larvæ of *Triphena pronuba*, which I was rearing for him for other purposes. I had 59 larvæ in different surroundings, and as this species, like *M. brassicæ*, buries by day, I used different-coloured materials on the floor of the cylinder, such as white sand, yellow gravel, pounded red flower-pot, and, in one case, small coal. The larvæ buried in all these, except in the coal, which they evidently disliked, but the results were, as in *M. brassicæ*, negative, with two possible exceptions from green surroundings, without any burying materials; these were, however, not very definite. The burying materials were in all cases used in addition to sticks of the suitable colour mixed with the food-plant.

Besides the foregoing experiments, I also made some notes on the red spots in *Smerimthus* larvæ, from larvæ of *S. tiliæ* sent me by Mr. Perkins at Mr. Poulton's request. These larvæ were all from parents which had been spotted in the larval stage. Unfortunately, many were injured by their transit by post, and I only succeeded in rearing four, which were all spotted. I also captured a larva of *S. populi* in which the spots were extremely well marked. The spots were certainly protective in effect, on account of their resemblance to the dark spots or blotches common on leaves of poplar, and this fact was long ago pointed out by Mr. Peter Cameron (*Trans. Ent. Soc. Lond.*, 1880); but although he considered the likeness to *galls* (*Phytoptus*) very striking, it seems to me, in *S. populi* at any rate, far greater to flat spots on the leaf seen with the light shining through them.

In *S. tiliæ* I studied the development of the spots very carefully, and in one individual I found them very linear and strongly suggestive of coloured borders; in the others they were much bolder and rounder, and presented quite a different appearance. Professor Weismann, as is well-known, considers the spots as on the way to develop into borders, while Mr. Poulton takes the view that we

have to do with a gradual contraction of borders into spot-marking. The spots certainly increase in area while developing, and if we are to regard the occurrence of spots as a recapitulatory character this fact would seem to support Professor Weismann's theory. If, however, they are reversionary, which now seems to me more probable, as they do not occur in all the individuals of a species, the increase in area would not have the same importance. The number of larvæ reared by me was, however, too limited to draw conclusions from safely, and had I had more individuals under observation, some might have presented different appearances.

LILIAN J. GOULD.

# VI.

## Cannibalism among Insects.[1]

IT is known that the caterpillars and larvæ of lepidoptera, crickets, and locusts feed on plants, of which they consume great quantities, in order to reach their full development or to prolong the imago condition, and to fulfil their mission of propagating the species.

Notwithstanding the vegetarianism of the insects mentioned, cases are known in which they abandon their usual habits and become addicted to a flesh diet, and, what is still more strange, they feed upon their own kind.

The larvicide instincts of the caterpillars of certain moths have been known for a long time, the cannibalism having been observed in various species deprived of their liberty, and brought up in confinement, either with or without vegetable food. Thus, for example, the caterpillars of the moths *Calymnia trapezina*,[2] *Agrotis ypsilon*, *Heliothis armiger*, and others, finding themselves in captivity, abandon their vegetable regimen and devour their companions, whether out of disgust at finding themselves imprisoned, or for want of fresh vegetable food, or for other causes of which we are ignorant. In any case, after the development of the disordered appetite, the caterpillars do not any longer care for vegetable aliment, and they endeavour to satisfy, in any way, their newly-acquired carnivorous habit. Out of a number of caterpillars associated together, of the above-named species, finally only one remains, which in the savage warfare, either by its strength or subtlety, has succeeded in saving itself, devouring the last of its companions which placed its existence in danger.

What has been just said only relates to caterpillars in captivity. So much greater is the fact which I discovered, that in the free condition there also exists cannibalistic larvicide. During my voyage in Southern Patagonia, in 1874, I noticed that the cannibalistic instinct was very prominent in the caterpillars of the district, whether free or imprisoned.

[1] Translated from the *Anales de la Sociedad Científica Argentina*, Nov., 1892, pp. 236–238.

[2] The caterpillars of this moth are said to be often carnivorous in the wild state, and to render considerable service to fruit-growers by devouring the destructive larvæ of *Cheimatobia brumata*.—ED.

All the caterpillars belonging to a particular group or family showed a preference for the flesh of their own relations. They devoured one another in considerable numbers, rarely feeding on the plants suitable for their nourishment. The caterpillars of the family of the Bombyces devoured their kin with skin and hair, and they went as far as to break through the cocoons in order to finish with the chrysalis within.

In a similar manner, the caterpillars of the Noctuids behaved with those of their own kind and with those of the Bombyces.

The caterpillars of these latter attacked also those of the former without any exception. The most voracious of the Noctuids was the caterpillar of *Heliothis armiger*; a single one of these consumed, in twenty-four hours, six or seven other caterpillars.

The caterpillar of the well-known butterfly, *Pyrameis carye*, is also a carnivorous cannibal, but with moderation, preferring always fresh plants to meat, while the others, and chiefly those of the Noctuinæ, after having tasted the flesh of their own kin, would no longer touch vegetable food.

I explain this particular character of the Patagonian caterpillars in the following manner. During the principal part of the summer in Patagonia there is considerable heat and dryness which causes the vegetation quickly to be parched up and scarce. When this happens the caterpillars lose their means of subsistence, but, in order that some may survive, the struggle for existence has taught them another means of subsistence, that is, the flesh of their own kind. Once this instinct has been inherited, the descendants will use it whenever an occasion presents itself, and, in many instances, even when there is no lack of vegetable food. In some cases it is necessity which produces the habit; in others, inheritance which leads up to it; thus new biological characters are formed.

Of other herbivorous insects cannibalism has been noticed in crickets in confinement. The first notice of this strange taste we owe to Sir W. Brodie (*Canad. Entom.* vol. xxiii., p. 137, 1891), whose observation has been recently confirmed by Mr. Philip Laurent (*Entom. News*, vol. ii., p. 180, 1891).

In an assemblage of many crickets kept for certain observations in a rearing drawer, or box (caja de herborizacion), the numbers diminished from day to day; at last only one—not a little fattened—remained by the side of the remains of his former companions.

Hitherto cannibalism among the crickets has been noticed only among captives, but I am now enabled to state that, under certain conditions, cannibalism is present among some Orthoptera in the free state, at all events among the locusts.

In the summer of 1883, in which the excessive heat and drought had brought about the nearly entire disappearance of the vegetation in a good part of the country, and more particularly in the broken country of the Banda Oriental, I had occasion to make a journey

from San José to Mercedes. At one place, Las Piedras, at which the diligence stopped, I noticed great numbers of locusts of the species *Pezotettix vittiger*, *P. maculipennis*, and *P. arrogans*, which covered the ground and rocks. My attention was attracted by the fact of seeing around one locust a number of other individuals of the same species, which were eating its soft parts even while it was yet alive and protesting vigorously. I saw different attacks, in which the conquerors, two or three at a time, got hold of the weaker members of their own kind, throwing them over, and opening the abdomen in order to devour the entrails, these being the softer and more savoury portions, since they still contained some of the vegetable food. Cannibalism here appeared in its lowest development, and the numerous remains of those which had been eaten bore witness to the extent to which the process had been carried.

In the face of facts of this character, it seems certain that nothing is sacred in Nature, when the prolongation of life, for the sake of the preservation of the species, is concerned.

CARL BERG.

## VII.

# The Classification of Arachnids.

NATURALISTS have long looked forward to a day when the systematic arrangement of living creatures will exhibit the real relationship which they bear to one another. All honest classificatory work helps science to realise this great ideal, but much is of the nature of raw material which may long remain without apparent use. Occasionally, however, we meet with contributions which seem to add considerably, and at once, to the progress of the work; and such are several recent memoirs on the spiders and their allies.

In 1851, Schiödte described a new genus of Malayan spiders, *Liphistius*, of most remarkable structure. This genus was at first classed with the Territellariæ—the tribe which includes the trap-door species, and the well-known large hairy "bird-killers" of the tropics. More recently Thorell has considered that the genus should form a tribe by itself, but be included with the Territellariæ in the sub-order Tetrapneumones, or spiders with four lung-sacs; and now Pocock (1) gives good reasons for assigning to *Liphistius* a still greater classificatory value, and placing it in solitary grandeur over against all other known spiders. Several striking characters seem to support this view. The abdomen in other spiders has lost nearly all traces of segmentation, but *Liphistius* exhibits nine dorsal and two ventral sclerites. The spinning-mammillæ, which in other spiders leave their embryonic position as ventral appendages of the abdominal sternites behind the lung-sacs, and migrate to the extreme apex of the abdomen, retain in *Liphistius* their primitive place beneath the middle of the abdomen. This latter character suggests the names proposed by Pocock for his new divisions, the species of *Liphistius* being called Mesothelæ, and other spiders Opisthothelæ. His primary division of these latter tallies with the old classification into Tetrapneumones and Dipneumones, but he agrees with Simon that the relationships of a genus (*Hypochilus*) of four-lunged spiders are with the latter rather than with the former group, and, therefore, suggests the terms Mygalomorphæ and Arachnomorphæ to supersede those time-honoured names. In all spiders of the latter group (except *Hypochilus*) the hinder pair of lung-sacs are replaced by tracheæ. *Liphistius* agrees with the Mygalomorphæ in having four lung-sacs, but, in several points, it shows affinities with the other division. Alone

among spiders it possesses four pairs of spinning mammillæ. While the Mygalomorphæ rarely have more than two pairs, the Arachnomorphæ always have three, and Pocock thinks that the extra central spinning organ (cribellum), found in some families of the latter, represents the fourth pair of spinners of *Liphistius* fused together.

In this new classification, therefore, the archaic characters of *Liphistius* are emphasised, and it is regarded as a survival of an ancestral form of spider in which the abdominal segments have not yet become fused, and still bear the spinners on their ventral aspect. The animal is, to some extent, a connecting link between the spiders and the scorpion-spiders (Pedipalpi). We are thus led to consider the relationships which exist between the various orders of the Arachnida—a subject also dealt with by Pocock in a later paper (2). His principal contention is that if arachnids are descended from ancestors which must have possessed a long series of nearly similar segments, those modern representatives of the groups in which the segmentation is best preserved must be the most primitive. On these grounds he considers the scorpions as the lowest living branch of the arachnid stem, in opposition to the views of Thorell and others, who have regarded them as the highest. There can be no doubt that Pocock's opinion will meet with general acceptance among biologists.

Deriving the arachnid orders immediately from an ancestor with a long abdomen of twelve segments and a telson, Pocock indicates the modifications which have probably occurred in each group. In the scorpions these segments are all present, but the hinder six are much reduced in bulk to form the post-abdomen, the telson being utilised as the sting. In the scorpion-spiders there has been a great reduction of the hindermost segments; the tail in *Thelyphonus* represents the telson. *Liphistius*, with its much-shortened and partially segmented abdomen, connects these with the higher spiders in which the abdominal segments are completely fused together. Nearly related to the Pedipalpi, but with tracheæ instead of lung-sacs, are the Solifugæ[1] and false-scorpions (Chelifers), with the number of abdominal segments complete, or but slightly reduced. On a higher branch of the stem bearing these come the harvestmen (Phalangida), with the abdominal segments generally reduced in number, and fused with the cephalothorax anteriorly. From these the mites (Acari), with the whole body fused together, must probably be regarded as a degraded offshoot.

The relation of the mites to the rest of the Arachnida has been also recently discussed by Bernard (3), who gives reasons for believing that these creatures are not examples of true degradation, but that they have become fixed at a larval stage of development. Comparing their digestive, vascular, and nervous systems with those of the

[1] Bernard (*A. M. N. H.* (6), vol. xi., 1893, pp. 28–30) has announced recently the discovery of a sensory organ on the pedipalp of *Phrynus*, similar to that on the homologous appendage of *Galeodes*.

higher Arachnids, he shows that they want the greater number of the abdominal segments, while they possess, in a fair state of development, organs homologous with those in the anterior part of the body of the higher Arachnids. He speaks of the Mites as "larval Araneids," but few naturalists will be inclined to regard them as a direct offshoot from the spiders. Extreme smallness—one of the supposed advantages gained by fixation at the larval stage—has been acquired by many true spiders. Moreover, spiders, like most other Arachnids, have no larval stage, but leave the egg in a form similar to that of the adult animal. Whether degraded or arrested, the affinities of the mites seem to be with the harvestmen, from which group they are not readily defined.

Trouessart (4), however, supports the view that, on account of their development with a metamorphosis, the mites should form a special sub-class of the Arachnida, and he separates the vermiform mites, such as the Phytopti, from the rest as a separate order; but the larval stage of mites (in which they have but three pairs of limbs) seems quite a secondary adaptation, for, according to Wagner (5) the fourth pair appear in the embryo, to be afterwards concealed beneath the skin of the larva and then to re-appear during metamorphosis.

It is remarkable that the theory of fixation at the larval stage has also been invoked by Von Kennel (6) to account for the origin of the microscopic "water bears" (Tardigrada), which have generally been regarded as degraded arachnids. He compares them with certain midge-larvæ (*Cecidomyia*) which have the power of parthenogenetic reproduction, and suggests that if male organs were also precociously developed a species might become permanently larval in form. Though he does not assert that the Tardigrada are "arrested" flies, the acceptance of his views—which certainly have much to support them—would probably lead to the removal of the group from the arachnids to the insects, in which the larval stage is often of such supreme importance.

The replacement of lung-sacs by tracheæ in several groups of arachnids opens up a question of much interest. Reference has been made in NATURAL SCIENCE (vol i., p. 524) to the supposed origin of the lung-sacs from the invagination or enclosure of gill-bearing appendages. If this view be accepted, we must regard the abdominal tracheæ in the higher spiders, harvestmen, false-scorpions, etc., as simplified lung-sacs. Pocock (2) suggests that increased lightness would be an advantage derivable from this change; but Bernard (3, 7, 8) considers the tracheæ the more primitive, and the lung-sacs elaborated from them. He would derive the whole ventral series of arachnid breathing-organs, spinning-glands, coxal glands, and poison-glands from the ventral setiparous glands of an annelid ancestor. The tracheæ of insects, on the other hand, he believes to have arisen from the dorsal series of setiparous glands, and he finds the hairy area around the stigmata of the chrysalis of the Vapourer Moth

(*Orgyia antiqua*) recalls an annelid parapodium with its setæ. This supposed difference in origin of the breathing-tubes in the two classes leads to a supposed corresponding difference in the origin of the limbs, those of the insects being traced to the ventral series of parapodia of the annelid, and those of the arachnids (and also crustateans) to the dorsal series. Ingenious as this theory is, the great cleft which it makes between the insects and arachnids by destroying the homology of their appendages, seems a grave objection. The higher annelids have undergone too considerable a development along their own particular line to be safely regarded as approximating to the extinct ancestors of a distinct phylum.

However, in a recent memoir, Sinclair (9) also suggests the derivation of lung-sacs from tracheæ rather than that of the latter from the former. He describes peculiar breathing-organs in the Scutigeridæ, consisting of dorsal slits opening into air-sacs, from each of which a number of tubes, arranged in two semicircular masses, are given off; these organs are believed to represent a stage between ordinary tracheæ and the lung-books of spiders, the lungs of scorpions representing the highest development of the series.

But the relationship between the various kinds of breathing-organs depends upon the question whether the lung-bearing or tracheate orders of arachnids are the more primitive. In the scorpions, we find four pairs of lung-sacs, and the full segmentation of these animals has already been dwelt upon as evidence of their archaic nature. Moreover, while palæontology has not yet thrown much detailed light on the history of the arachnid groups, strong confirmation of this view is derived from the fact that remains of scorpions occur in the Silurian rocks, and that these are the oldest air-breathing animals of which we have certain knowledge. In the scorpion-spiders, and in the lower families of the true spiders, two pairs of lung-sacs occur, but in the higher spiders, as already mentioned, the hinder pair of these are replaced by tracheæ. Here, again, such knowledge of fossil spiders as we possess supports the view that lung-sacs preceded tracheæ, for while four-lunged spiders lived in Carboniferous times, the higher members of the group have only been found fossil in Tertiary formations. The comparatively recent orgin of the higher spiders is also suggested by a study of their distribution, most of the families and genera being world-wide in their range. Marx (10) has recently remarked that among 292 species of spiders from the Arctic regions, none can be referred to special genera; and British naturalists who have read Hudson's "Naturalist in La Plata" must have observed that, while the mammals and birds and insects described are far removed, indeed, from our native animals, in the chapter on spiders we are introduced to such familiar friends as *Tetragnatha*, *Zilla*, *Pholcus*, and *Argyroneta*. Among the four-lunged spiders we meet with the confined and discontinuous distributions so characteristic of old-time groups of

animals. For example, Simon (11) has recently described a new genus *Myrtale* from Madagascar, whose nearest affinities are with *Moggridgea* from South Africa, and *Migas* from New Zealand.

The remarkable group of marine arthropods known as the "sea-spiders" (Pycnogonida) were for long regarded as arachnids by some zoologists, and as crustaceans by others. Of late years, the great authority of Hoek and Dohrn has led to the relegation of these animals to a position independent of either group, indicating their supposed independent descent from vermiform ancestors. Recently, however, Morgan (12) has re-advanced the view of their arachnid affinities, dwelling on the similarity of the polar delamination observed in the division of their eggs to what occurs in the eggs of arachnids, and also on the presence of intestinal branches in the limbs, another arachnid character. The number of appendages is the great obstacle to bringing the pycnogons into line with the arachnids. Their four pairs of walking-legs, their chelate foremost jaws, and their palps are easily represented among arachnids, but what is to be done with the pair of extra limbs, behind the palps, on which the male—a true nursing father in this group—carries the eggs and young embryos? If we are to retain the pycnogons among the arachnids, we must either derive these extra limbs from a segment which has become aborted in the latter, or else, comparing them with the first pair of legs of a spider, regard the pycnogon's last pair of limbs as belonging to the abdomen.

The semi-parasitic life of pycnogons on hydroids, polyzoa, and other marine animals has always suggested that they are a degraded group, and degradation often masks affinity. In recent systematic work on pycnogons, Schimkewitsch (13) and the present writer (14) have directed attention to the relationships between the genera, and the former insists that the most primitive genera are those of most complex organisation. Not only do the number of appendages tend to lessen, the chelæ or palpi or both disappearing, but the number of joints in the appendages decreases and the beautiful and complicated serrate processes on the egg-bearing legs in the higher forms—the Nymphonidæ, for instance—degenerate into ordinary spines as we descend through the various series. There are few groups of animals in which a comparative study of adult living forms does not suggest the lines upon which progress has been made. In the pycnogons, however, as in most parasitic or semi-parasitic groups, such study can only tell us a tale of decline.

## REFERENCES.

1. **Pocock, R. I.**—*Liphistius* and its bearing on the Classification of Spiders. *Ann. M. Nat. Hist.* (6), vol. x., 1892, pp. 306–314.

2. ————.—On Some Points in the Morphology of the Arachnida, with Notes on the Classification of the Group. *Ibid.*, vol. xi., 1893, pp. 1–19, pls. i., ii.

3. **Bernard, H. M.**—Some Observations on the Relation of the Acaridæ to the Arachnida. *Journ. Linn. Soc. Zool.*, vol. xxiv., 1892, pp. 279–291, pl. xx.

4. **Trouessart.**—Considérations générales sur la Classification des Acariens, suivies d'un Essai de Classification Nouvelle. *Revue des Sciences Nat. de l'Ouest*, 1892.

5. **Wagner, J.**—Zur Entwicklungsgeschichte der Milben. *Zool. Anz.*, vol. xv., 1892, pp. 316–320.

6. **Kennel, J. von.**—The Affinities and Origin of the Tardigrada. *Ann. M. Nat. Hist.* (6), vol. xi., 1893, pp. 197–204 (transl. from *Sitzsb. Naturf.-Gesell. Univ. Dorpat*, vol. ix., 1892, pp. 504–512).

7. **Bernard, H. M.**—An Endeavour to show that the Tracheæ of the Arthropoda arose from Setiparous Sacs. *Zool. Jahrb.* (*Anat. and Ontog.*), vol. v., 1892, pp. 511–524.

8. ——————.—Additional Notes on the Orgin of the Tracheæ from Setiparous Glands. *Ann. M. Nat. Hist.* (6), vol. xi., 1893, pp. 24–28.

9. **Sinclair, F. G.**—A New Mode of Respiration in the Myriapoda. *Proc. Roy. Soc.*, 1891, pp. 200–201 (*A. M. N. H.*, vol. ix., pp. 263–4) *Phil. Trans. R. S.*, vol. 183B, 1893, pp. 61–72.

10. **Marx, E. A.**—A Contribution to the Study of the Spider Fauna of the Arctic Regions. *Proc. Ent. Soc. Wash.*, vol. ii., 1892, pp. 186–200. (Abstract in *Amer. Nat.*, vol. xxvi., 1892, pp. 968, 969.)

11. **Simon, E.**—Descriptions d'espèces et de genres nouveaux de la famille des Aviculariidæ. *Ann. Soc. Ent. France*, 1891, pp. 297–312.

12. **Morgan, T. H.**—A Contribution to the Embryology and Phylogeny of the Pycnogonids. *Stud. Biol. Lab. Johns Hopkins Univ.*, vol. v., 1891, pp. 1–76.

13. **Schimkewitsch, W.**—Notes sur les Genres des Pantopodes. *Arch. Zool. Exp. et Gén.* (2), vol. ix., 1891, pp. 503–522.

14. **Carpenter, G. H.**—Reports on the Zoological Collections made by Professor A. C. Haddon in Torres Straits, 1888–9. Pycnogonida. *Sci. Proc. R. Dubl. Soc.* (N. S.), vol. vii., 1892, pp. 552–8, pl. xxii., vol. viii., 1893, pp. 21–27, pl. ii.

Geo. H. Carpenter.

## VIII.

# The Great Barrier Reef of Australia.[1]

THE Great Barrier Coral Reef of Australia is 1,250 miles long, stretching along the coast of Queensland from Torres Straits to Lady Elliot Island. The distance from the outer edge of the reef to the mainland varies from 10 to about 150 miles. Already raw material to the value of £100,000 is obtained annually from the reefs and the intervening water, and is exported from the colony.

The chief items in this produce come from the pearl, and pearl-shell, and the Trepang (or Bêche-de-mer) fisheries. In addition to such commercial interest, the great Barrier Reef is of the greatest scientific interest from the material it provides for collecting information as to the external features and detailed composition of coral reefs.

Mr. Saville Kent, Commissioner of Fisheries to the Government of West Australia, was afforded the opportunity, by the wise liberality of the Queensland Government, of making a detailed examination of this great reef. This sumptuous volume contains the first results of his labours. He hopes to publish fuller and more technical accounts of various animals examined at a later date. The present volume is designed to give both the scientific and the general public an idea of the vast and wonderful medley of life presented by a coral reef.

An interesting and novel feature of the volume is its copious illustration by photo-mezzotype plates.[2] These provide for us a series of pictures of the coral reef of almost unimagined beauty and value. As the reefs are uncovered only for short intervals, and under conditions unfavourable for drawing, we have had as yet, except for the verbal descriptions of observers, no idea of the actual appearance of a reef. At the end of the volume there are sixteen chromo-lithographic plates. It is impossible to deny that these are, artistically, far from pleasing; but even if they are exact representations of the animals, it may well be that the glaring colours of the tropic seas removed from the brilliancy of tropic sun to the cold atmosphere of England seem harsh and crude. Moreover, the æsthetic value of

[1] THE GREAT BARRIER REEF OF AUSTRALIA; ITS PRODUCTS AND POTENTIALITIES. By W. Saville Kent, F.L.S., F.Z.S., F.I.Inst. With a Chart; 48 Photo-Mezzotype plates; 16 Chromo plates; and many Woodcuts. Pp. 380. 4to. London: W. H. Allen & Co., 1893. Price £4 4s.

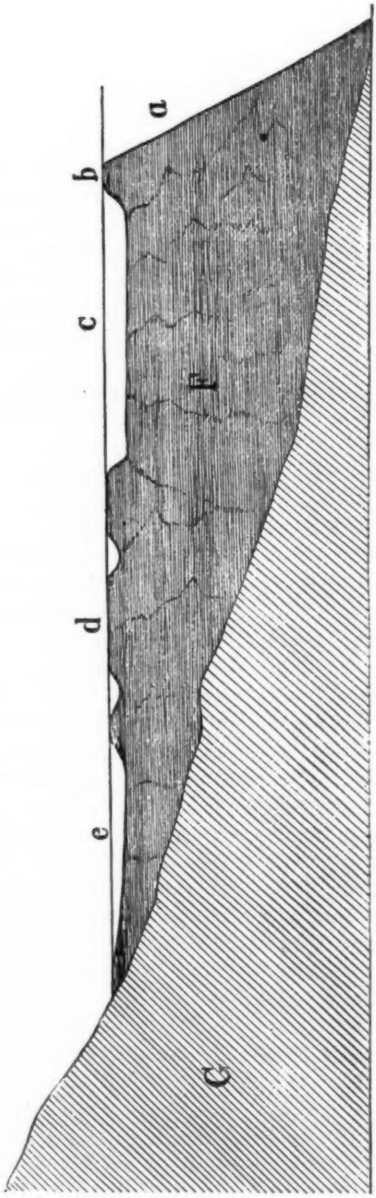
[2] See NATURAL SCIENCE, vol. i., p. 648.

colours is a mere convention—as anyone may observe who takes his pleasure in the Row this season.

Geologists and others will perhaps turn first to the section of the book which deals with the origin of coral reefs.

A figure which by the kindness of the publishers we have been able to reproduce shows how the reef forms an enormous buttress of rock F pressed against the sloping granite rocks G of the coast. Mr. Jukes, and after him the author, made most careful search for any evidence of upheaval, but failed to find facts against Darwin's subsidence hypothesis. At many points along the reef enormous masses of storm-raised coral at first sight simulate the effects of upheaval; but of exact evidence Mr. Saville Kent could find nothing to oppose seriously the subsidence theory. At many stations along the reef, large expanses of dead coral intervene between the living banks and high-water mark. Such banks are subjected to destructive atmospheric influences at every spring-tide, while living coral is above water only at the lowest spring-tides. Dead bivalve shells of large size such as *Tridacna* and *Pinna* occupy their original positions in close contiguity to the dead corals; but all these results could have been caused by upheaval of a foot or two, and there is practically no evidence for a prolonged era of upheaval.

On the other hand, all of the few big breaches in the Barrier's outer rampart are opposite large estuaries. They are at present too remote from the estuaries (from 30 to 60 or 80 miles) for the influence of fresh-water to have retarded coral growth. This condition is by itself strong evidence for subsidence, but Mr. Saville Kent relies most strongly on the evidence from the geographical distribution of animals that Australia had in former times a land-connection with New Guinea. It is not worth while to recapitulate the facts here, as all who are specially interested in the controversy will refer to Mr. Saville Kent's book; but he concludes that the construction of the Great Barrier of Australia under conditions of subsidence, and in accord with the original hypothesis of Mr. Darwin, is proved. Towards the end of Tertiary times the great Barrier Reef existed as a simple fringing reef, and moderate subsidence, of the occurrence of which we have abundant geological evidence, has turned it into its present condition. Mr. Saville Kent brings forward a considerable additional quantity of evidence supporting parts of the reef-formation theories of Murray and others. Although the Barrier Reef as a whole has been formed by subsidence, in the details of the process conditions of local growth and decay have played a large part. Thus, much of the actual bulk of a reef is formed of coral *débris*—*débris* which comes from the breaking up under the influence of storms of the rapidly-growing, more fragile forms of coral. On a reef at any time only a small area is actually alive, and that small area is turned most usually away from the mud and fresh-water on the landward-side, and turned towards the most abundant and freshest




DIAGRAMMATIC TRANSVERSE SECTION OF THE GREAT BARRIER REEF OF AUSTRALIA.

G.—shore of granite. F.—coral reef. *a.*—deep seaward face of reef. *b.*—actual barrier. *c., e.*—clear channels. *d.*—inner reefs.

(Vertical scale much exaggerated)

supplies of sea-water. Again, nearly all masses of coral grow more or less like a fairy ring—living and expanding at the edges, decaying, getting ground down into *débris*, or dissolved by the sea-water at the centre. The action of various forms of life living on the coral also assists this process. Shell-fish grow on the coral and become embedded in it, and round the intruding giant clams embedded in the coral waves a region of decay is usually present.

A valuable part of the book is occupied by an account of the actual corals and coral animals. To those who are familiar only with the bleached and dried specimens of museums and cottage windows, the account of the marvellous colours of the living corals will be a revelation. The soft tissues of the polyps have all the colours of the rainbow—sometimes blended in soft and delicate shades, often in the most startling and violent mixtures. The other reef-living animals—animals like the star-fishes, sea-urchins, sea-cucumbers, crustacea, and shell-fish—which contribute to the lime-supply of the reef, and the various fishes living in the shallows, all are similarly radiantly attired.

Foraminifera are present in abundance, and their calcareous shells form the slimy mass of the white "sandy patches" that intervene between the coral banks.

The Nullipores or coralline seaweeds form encrusting masses over the reefs rather like Madrepores, but growing to a height considerably above the Madrepore localities. Those on the surface are chiefly pink or lilac, and so they give a characteristic appearance to the reefs they infest. Other Nullipores (*Halimeda*) grow in deep pools or on the sea-bottom, and are brilliantly grass-green.

Everywhere on the reef sea-anemones are found in abundance. Most striking are some giants belonging to the genus *Discosoma*. Some of these had discs of between one and two feet in diameter and acted the part of hosts to two species of fish and a species of prawn. In *Discosoma kenti* there were almost invariably one or two specimens of a percoid fish about three inches long. When a stick was thrust into the mouth of the anemone the fish swam out, but when the disturbance was over returned to the seclusion of the anemone's stomach. A prawn about two inches long had similar quarters. Both the fishes and the prawns were brilliantly coloured.

The tentacles of many of the reef-living anemones were conspicuous for length and branchings like the fronds of a fern. Many of the anemones, especially those with peculiar tentacles, have the power of stinging.

Among the corals themselves almost every variety was found, and Mr. Saville Kent has the materials for a large addition to recorded species and genera; but most interesting are his numerous descriptions and figures of the appearance and colours of the living expanded polyps. By an ingenious arrangement of his camera he took many photographs of the expanded corals either in their normal

positions in shallow parts, or when they had expanded in his tanks and tubs.

Among the Alcyonarians, the Alcyonidæ, from their number and abundance, are very conspicuous on the living reefs; but as their most abundant forms possess a flexible corallum with separated spicules of lime, they break up on death and add only to the general powdery *débris*.

*Tubipora*, the organ-pipe coral, is present for the most part not in large patches, but scattered about further inshore than ordinary corals, and in regions where there is much muddy sediment. *Heliopora cærulea* was found in abundance, and while the author now confirms Moseley's reference of the Heliopores to the Alcyonarians, he is inclined to believe that a part of the corallum is built up by commensal worms closely allied to the *Leucodore ciliata*, which did so much to destroy the Australian oyster-fisheries. The account in the book, however, would be equally consistent with a purely parasitic relation of the worm to the coral.

A new sheaf-shaped Alcyonarian, called *Xenia pulsitans* by the author, and found in Torres Strait, is remarkable not only for the size and delicate colouration of its polyps, but for certain special physiological manifestations. "The expanded tentacles in this type measure over an inch in diameter. The colour of the stalks and of the main shafts of the tentacles is a pale beryl-green, while the conspicuous tentacular pinnæ, and the substance of the common supporting polypary, are a pale ochreous-brown. The special physiological phenomenon observed of this type was associated with the movements of its tentacles. In all ordinary polyps, whether belonging to the coral-secreting or skeletonless sections, the component tentacles move quite independently of one another, and their action is either irregularly vermiculate, or one of simple expansion and retraction. In the present type, on the contrary, all the eight tentacles move synchronously, opening out and contracting in a continuous measured rhythm, averaging two seconds to each contraction. The action thus observed was in all respects identical with the pulsating contractions of a jelly-fish, and was suggestive of a less remote affinity between the Alcyonarian tribe and the medusiform Hydrozoa than subsists between the last-named tribe and the coral-forming Madreporaria or skeletonless Actinozoa. This suggestion of affinity receives substantial support from the fact that as the radial processes throughout the jelly-fish tribe are invariably a multiple of four, and most commonly eight, they thus correspond in number with the tentacular organs of an Alcyonarian."

Among the Hydrozoa the only generic type that contributes to any material extent to the formation of the reef is that of Millepora. The brilliant *Distichopora coccinea*, which resembles *Corallium rubrum* except that its skeleton is commercially valueless, is found not infrequently.

The pearl and pearl-shell fisheries are of great importance. As an export from Queensland, pearl shell has ranked for the last five or six years as the sixth or eighth most important substance. These fisheries are confined to the tropical area of the Queensland coast, and are intimately associated with the Barrier-reef. The mother-of-pearl shell is collected in water from 7 to 20 fathoms deep. Formerly it was found in areas practically exposed at low tides. Queensland derives a revenue from licenses required to be taken by boats, ships, and sailing masters, and from a small royalty on the amount of shell collected.

Owing to considerable depletion of the more readily accessible fishing grounds, the average weight of shells has decreased. Large shells weighing six to eight pounds a pair are still to be got, but the more ordinary yield averages two-and-a-half pounds the pair. A protecting Act of Parliament now prohibits the taking of shell with a less diameter than six inches across the pearl lining or "nacre."

The specific form of the Queensland waters is *Meleagrina margaretifera*. Actual pearls of large size and fine quality are found, but enormous numbers of the shells contain worthless forms.

Some experiments have been made in the artificial production of pearls, not according to the Chinese methods by introducing metallic or other foreign bodies into the mouth to be covered by a pearly coat, but the process has as yet only a speculative value.

The author made a series of experiments with a view of finding methods of removing young shells from the breeding grounds to shallow water where they might grow to maturity in undisturbed security. He found that young living examples with a diameter of no more than a quarter of an inch might be safely removed by cutting through the byssus. When the animal was placed in an aquarium the remains of the byssus were ejected and a new byssus secreted, and in most cases a secure reattachment formed in the new habitat. The animals have a slight power of locomotion, but nothing comparable with the active movements of pectens.

In removing larger shells from deep water for relaying in shallow water, several methods were tried. Some were placed in shady places on deck and had sea-water thrown over them at intervals. For others, the American method (employed in the case of oysters)—muzzling the shells with wire to prevent the opening of the valves—failed to secure the retention of the fluids in the shell, as they escaped by the byssus groove. The mortality in these two cases was very great, but entirely successful results were obtained when the shells were kept in tubs of water, the water of which was changed every few hours, and the actual shells immersed in basket-work frames in the sea at night.

When these shells were laid down in frames in shallow water where the water was pure and the currents strong, remarkably healthy and active growth took place. It may indeed be said that

Mr. Saville Kent has succeeded in demonstrating the practicability of pearl-shell farming.

An interesting and curious chapter deals with the Bêche-de-mer or sea-cucumber fisheries. The food of the sea-cucumbers consists almost entirely of foraminifera which are swallowed in combination with large quantities of shell and coral sand. So physiologically the sea-cucumbers are the earth-worms of the sea, and pass through their bodies immense quantities of material in process of getting the scanty food substances contained in it.

The animals are prepared entirely for the Chinese market. They are collected by hand in sacks at low water. Immediately on their arrival at the curing stations they are placed in large cauldrons of water and boiled for twenty minutes. They are then split open, gutted, partially dried, and finally smoked, the favourite wood being that of the red mangrove (*Rhizophora mucronata*). The prepared animals should be perfectly dry and crisp. Mr. Saville Kent does not, unfortunately, give further directions in the matter, though one would have liked to know the recipe for their final cooking, and any commendation or otherwise of their flavour.

Little seems to be known of the rate of growth of these Holothurians. A good many forms are present. The cotton-spinners have no commercial value; many others from the soft texture of their tissues cannot be cured. The author sent a complete set of specimens to the British Museum, where they have been described by Professor Jeffrey Bell. *Holothuria mammifera*, called by the appetising Chinese name Se-ok-sum, appears from its market price to be the surest tickler of the Celestial palate, but *Actinopyga obesa*, under the name of Hung-hur, runs it close.

While the Bêche-de-mer fisheries have yielded an average of £23,000 a year, the Queensland oyster fisheries produce only about £8,000 a year. The oyster is *Ostrea glomerata*, the "rock oyster." Other forms are quite edible and wholesome, but have not yet secured a market. The oysters occur in the tropical waters, and so come into the Barrier Reef fauna, but the actual fisheries are, for the most part, south of the reef. *Ostrea glomerata* has a number of well-marked varieties. The shallow-water forms are the most typical, and have luxuriantly frilled and convoluted marginal borders, and bright colours. The deep-water varieties have a smoother and more ponderous form, often an abnormally elongated contour, and are much less conspicuously coloured.

The old travellers' tales are realised, and in the region of the Barrier Reef oysters are to be found growing on trees. That is to say, one of the most favoured habitats of the "rock oyster" is the exposed roots and respiratory shoots of the white mangrove (*Avicennia officinalis*.)

The oyster has many enemies. A small boring whelk (*Urosalpinix paviæ*) does immense damage, especially among the young oysters. Mr. Saville Kent seems doubtful as to whether or no the star-fish

deserves its evil reputation in this matter, but until its innocence be established he recommends its wholesale destruction.

The common sting-ray, *Trygon pastinaca*, is most destructive, and *Cestracion philippi*, the Port Jackson shark, makes use of its crushing teeth to very evil effect among the oysters. Boring sponges, birds, and various other forms of life prey on the oyster, but the most destructive pest is the small worm, *Leucodore ciliata*, whose ravages were first described by Mr. Whitelegge.

In a special chapter, entitled "Food and Fancy Fishes," the author deals with some of the 900 recorded species of Queensland fish. Among food-fishes, those of the Northern district belong to the Indo-pacific or Oriental region. The trumpeters and barracutas, which are so important in the fish-markets of New Zealand, are practically unrepresented in Queensland. The best known forms are *Lates calcarifer* (the "Cockup" of the Calcutta market), and the smaller *Lates colonorum*. Mullets, gurnards, sea-pikes, flat-fish, and many well-known forms abound. Eight species of herring (*Clupea*) have been recorded, but, as yet, have not been utilised for commercial purposes. Altogether, the "unvintageable sea" seems to be remarkably prolific, and Mr. Saville Kent makes out a good case for regarding the Barrier Reef as one of the most remarkable commercial advantages of Queensland. In a concluding chapter entitled "Potentialities," he points out how, under proper scientific advice, this commercial advantage admits of almost indefinite extension. As the population of Australia increases, the value of so large an area of prolific sea-life will become almost inestimable, and, quite apart from the scientific value of Mr. Saville Kent's beautiful volume, Queensland is to be congratulated on taking so efficient means as the assistance of this work to develop its resources. On the side of practical utility it were hard to see how Mr. Saville Kent could have done better work. He has surveyed the actual resources of the reef and has shown the small use that is at present made of them, bringing to the task not only a trained scientific mind, but a large special experience.

To those who spend their days in laboratories and museums, and who will eagerly turn to the separate scientific accounts that have been, and will be, published on Mr. Saville Kent's collections, this work is equally invaluable; for here are the animals, not as specimens with names new or old, hinging on some obscure point in anatomy or doubtful question of priority, but the animals alive, in their actual places in the world, in their crowded environment of friend and foe, of sunlight and waters. In this short sketch of the book very little has been said of its most valuable scientific feature—the faithful and minute account it gives of the actual appearances presented by a living coral reef; but as the value of this account is inseparably associated with the beautiful photographic plates, those interested must be referred to the book itself.

# SOME NEW BOOKS.

THE GERM-PLASM: A Theory of Heredity. By August Weismann. Translated by W. Newton Parker, Ph.D., and Harriet Rönnfeldt, B.Sc. Contemporary Science Series. Pp. 477. With 24 illustrations. London: Walter Scott, 1893. Price 6s.

THE new volume of Professor Weismann, of which the translation is before us, departs from the historical method in which we have received his work. This is a deliberate presentation of his theory, incorporating, expanding, and explaining the ideas which have been shaped in his various essays. At the same time, it contains a number of novel hypotheses subsidiary to the theory, but necessary to it. It is not too little to say that the book is an excessively hard nut to crack, and that many will declare the kernel bitter who have not bitten through the epicarp.

Speaking generally, this expanded account is a closer and more detailed theory of the structure and mechanism of the germ-plasm, bringing it closer into relation with, on the one hand, recent advances in actual observation of the structures and changes in the nucleus connected with cell-division, and on the other, with the observed details of inheritance, variation, asexual reproduction and regeneration of tissues.

As before, the doctrine of the continuity of the germ-plasm is firmly insisted on, and it may be said that this, of all parts of Professor Weismann's theory, has been subjected to the least successful criticism, and has received the most startling corroboration. This germ-plasma Weismann identifies with the chromatin fibril in the nucleus of egg-cells and sperm-cells. Before fertilisation, the nuclear fibril breaks up into a series of loops which Weismann calls idants. In ordinary sexual eggs the number of idants is twice halved, and by what Weismann calls these two reducing divisions the polar bodies are extended. It will be remembered that, originally, the first polar body was considered by Weismann to serve for the extrusion of that part of the nuclear matter which, having served to guide the maturation of the ovum, became useless when the ovum was mature. In his completed doctrine, he finds in the two polar bodies of normal sexual cells, and in the single polar body of parthenogenetic ova, a mechanism for reducing the bulk of germ-plasm—part of the apparatus for phylogenetic variation. The actual nuclear matter which controlled the maturation of the ovum he supposes to have passed into the protoplasm of the ovum, and, therefore, to be out of the reckoning when the behaviour of the nucleus is being interpreted.

When the nuclear loops or idants are closely examined they exhibit a series of lumps or divisions as if they were built up of separate pieces like draught counters strung together. These sepa-

rate pieces Weismann names "*ids*," and suggests that the facts of inheritance might be accounted for if each id contained the possibility of producing the individual. On such a hypothesis Weismann shows most ingeniously and convincingly how the observed marshalling and sorting, division and rejection of idants and ids would form a mechanical apparatus compatible with the complex phenomena of inheritance to be accounted for. The next stage of his theory still is along the path of observation. A certain number of idants with the contained ids remain unused in each individual development. Occasionally, but rarely, they are passed at once into a cell which becomes the future mother sperm or mother ovum cell, and so the sperm-cells and egg-cells of the individual arise directly from the idants present in the fertilised egg-cell. More frequently, however, the set of idants and ids are handed on passively from cell to cell during the development of the individual, until they ultimately reach the place in the individual where the sexual cells are to be formed. This path of the germ-plasm he calls the "germ-track," and, as will be remembered, it was his original hitting upon such germ-tracks in the Hydrozoa that led him to suspect the existence of a germ-plasm. Turning again to that part of the germ-plasm which is to form the actual individual, we come to entirely theoretical matter. It consists of *ids*, and each *id* contains the possibility of a complete individual. The *id* is not a structureless substance, but possesses a definite historical architecture—the expression of the past history of the species. Each *id* is built up of smaller units, the "determinants," and there is a "determinant" for each cell or group of cells in the animal or plant body which can vary independently. As development goes on the *ids* gradually break down, throwing off in the order determined by their historical architecture the determinants to rule the structure of the "determinates" or independently varying parts of the organism. Thus ultimately we come to determinants passed during cell-division into their appropriate cells. In these cells the determinants break down into the final units or "biophors" which pass through the nuclear membrane into the protoplasm of the cell. Thus the "idioplasm" or chromatin derivative which rules the cell consists of Weismann's theoretical determinants, and it rules the cell by the passage of actual material particles into the protoplasm. These biophors—the ultimate units of the germ-plasm—are, at the same time, the primitive units of life, and Weismann conceives life as having originally consisted of independent biophors.

For each of the units of the germ-plasm Weismann postulates the common property of living material, the power of growth and reproduction by division. This has of course been observed in "idants" and is a ready inference for "ids."

It is to be noted that a number of ids, each with the complete power of producing an individual, are present in the development of an individual. Thus there comes about the struggle between the determinants and biophors coming from ids with slightly different peculiarities, and thus the particulate variability of the parts of an organism and the particulate resemblances to parents and ancestors have a possible material apparatus.

As the whole volume consists of a subtle and ingenious translation of biological phenomena into the terms of this theoretical apparatus, it is obvious that only a study of the book can give an idea of the exactitude with which the phenomena correspond with the apparatus; and for this reason a sketch like the above removed from the com-

plexity of the observed phenomena of which it is the abstraction necessarily will seem artificial. To those who are inclined as they read these lines to cry out on the artificiality, I can only say—work through Weismann's application of his theory and see what a master key it seems to the confused tangle of life.

While at first sight this theory seems to present only a formal simplification of the facts of heredity, inasmuch as it seems to put on the biophor the whole mystery of life, I am inclined to think that this objection is not valid; for if the mechanical marshallings and evolutions and devolutions of the biophor and its higher aggregations do actually form a picture in little of the larger complexities of the visible world, we can at once remove from the problems to be solved these actual complexities. We shall, in fact, by Weismann's help, effect a separation of those problems of living material which are functions of the complexity of organisms and not actual difficulties of living matter itself; and those who are familiar with the recent advance in our knowledge of the elaborate marshallings and evolutions and devolutions of the chromatin in dividing nuclei, can hardly say that Weismann's postulated movements of the elements of the germ-plasm make a large demand on credulity; but this depends upon our being able to see clearly that the mechanism is a possible one. I freely admit that as yet I have not assimilated Weismann's book sufficiently to follow the clear image that is obviously present in his mind. He expressly states that he has felt the difficulties in giving up an epigenetic view of ontogeny.

It will be seen that, leaving out the foregoing considerations, we are led up to the ultimate problem in the biophor. That is really the problem of assimilation, and is the factor as yet unexplained in any theory of biology. The possible migration of biophors from the nucleus to the protoplasm usefully shifts the problem of "fernwirkung" (the translator rather unhappily renders this "emitted influence," instead of the obvious "action at a distance") to the protoplasm itself. When we understand how protoplasm can feed and grow, we shall probably have little trouble in understanding the nucleus.

P. C. M.

---

THE MICROSCOPE: Its Construction and Management. Including Technique, Photo-Micrography, and the Past and Future of the Microscope. By Dr. Henri Van Heurck. English Edition. Translated by Wynne E. Baxter, F.R.M.S., F.G.S. With plates, and upwards of 250 illustrations. London and New York: Crosby Lockwood & Son, 1893.

THE English microscopist has, for at least a generation, shown that he is sufficiently in earnest to be cosmopolitan. He can welcome warmly good English work, in either the manufacture or the use of the microscope, or in the excellence of a treatise on its principles and application. But there is definite evidence that he has learned to prefer the quality of an instrument or a handbook to its source. In fact, there is danger that the foreign maker, having obtained by sheer excellence and moderate prices an assured position in this country as the producer of the principal optical elements of the microscope, that the prejudice runs wholly in favour of instruments of foreign production, to the sacrifice of much that is of really higher excellence made in this country.

In the matter of handbooks, however, there is probably no country that has met the wants of the beginner and the skilled amateur so fully as England. Carpenter's "Revelations of the Microscope" has, in each of its seven editions, held its own not only in England and America, but has been largely used on the Continent. Nevertheless, and, perhaps, indeed for this very reason, there is no country in the world where the great Diffraction theory of Abbe, explaining the principles of vision with the modern microscope, has been so critically and, at the same time, so warmly and generally received as in England. At the same time, there are few working microscopists whose shelves are without *Handbuch der Allgemeinen Mikroskopie* by Dr. Leopold Dippel; and it may be safely predicted that the splendid *Theorie der Optischen Instrumente nach Abbe* by Dr. Siegfried Czapski, which has just come from the publishers' hands in Breslau, will anywhere find a more appreciative circle of students than in England; but the English microscopist, who is not only a student of what the microscope does and can reveal, but also a critic and connoisseur of the principles and modes of manufacture of the instrument, really needs books of the class above indicated. The day for handbooks that are better illustrations of the art of the printer and the wood engraver than of the science and art of microscopy has passed away.

In the treatise now before us great pains has been taken to present in its most attractive form the facts of microscopical science as known to us ten or fifteen years ago, and to make an appendage to these of the most recent knowledge which has come to us as the result of theory and practice in more recent times; but between the old and the new there is no coherence. The treatise purports to cover all the area of modern microscopy, in the interests and for the benefit of the amateur. That it fails of its purpose there can be no doubt. It does this partly because of its method. It adopts the older style of teaching, and simply forces the new optical doctrines and details of the new methods of manufacture and manipulation (where given at all) into a place or position in the text without preface or explanation. The result is that we obtain an account of the "Theory of Microscopic Vision" which is in itself excellent, but quite beyond the range of the class of reader for whom the book is ostensibly written, because, clear as Abbe is in the exposition of his great theory, it needs at least a chapter of explanation and introduction to make it fully accessible to the ordinary, and especially the non-mathematical, reader. The result is, that this book appears to us to fail from the fact that it directs the student to go beyond his depth, without even the semblance of assistance on the one hand, and, on the other, guides him with great care over shallows where no guide was needed, save the catalogues of certain English and foreign opticians—that is, as to the forms of certain instruments mostly on the same type.

It is quite true that the tyro wants above all things to know how wisely to purchase an instrument; but this is not unfolded to him by an indiscriminating description of the microscopes of certain makers however diverse, but by an unbiased description of the *essentials* of *any* good instrument, and such an account of practical tests as would enable a beginner at least to see how far a certain pattern of stand, or a specific instance of workmanship, answers to this set of requirements. And in furnishing these data there need be no more dogmatism than in an experienced photographer's affirmation

of what is indispensable in a thoroughly good and practical camera—always in both cases keeping the specific object which is sought in view.

It is true that Dr. Van Heurck has presented us with a very attractive model of a microscope for "the study and photography of Diatoms, and all delicate researches," but the model has not many new or specially advantageous features when considered as one of the many English models before the public. It has, as we think, in common with some of the very finest English workers, some distinct disadvantages; but it certainly overcomes the difficulty of the working of the fine adjustment on good conditions better than any instrument that we know of the Jackson model (which is in practice an inferior form) that adopts similar methods. The fine adjustment is delicate, and the instrument is throughout supplied with admirable facilities for accuracy and ease in use. Hundreds of skilled workers would refuse it at once as representing the best possible form of a modern microscope; but much has been done to soften the evils inherent in the form. Yet all these are costly, and when they are effected we are bound to submit that it is not the best form of the instrument that is either possible or accessible; and, above all, it is not the best form of the instrument that can be constructed at a low expenditure.

The amateur wants a useful, well-made instrument at a low cost. So does the medical student. What, therefore, is essential to a good microscope in any form? What form of stand has the largest number of points in its favour, practically considered? and which are the stands of the modern makers, English, Continental, or American, that, at a moderate cost, most largely meet these requirements?—these are the considerations which are of the greatest value to the purchasers of modern handbooks, from this side of the subject, and its efficient discussion would involve a consideration of that most practical of all questions in such a treatise, the relative values of the English as against the Continental stands, or *vice versâ*; but this is wholly avoided.

There is one other point which we desire to touch but lightly, it is that here and there in the book phraseology has been adopted that certainly does not represent, if it does not absolutely run counter to, the diffraction theory of microscopic vision. It is not necessary to dwell on this; probably it may in some instances be inadvertence; but in a treatise intended to teach *ab initio* the doctrines of Abbe on the optics of the modern microscope, especially as there is some obscurity in the inculcation of these, it is unfortunate to find incidental passages that imply not only complications but contradictions.

The translator's work has manifestly been done with care and sincerity, and most fairly presents the meaning of the author; and the book, though large and heavy for use at the work-table, is unusually good.

There are many points of excellence in the work, and some that give evidence of the practical skill of the author; indeed we can see the possibility in a second and greatly revised edition of a book of high quality and usefulness; but it will involve the excision of much that is now useless in its pages, and the rendering useful by ample and lucid preface and explanation of much in it that, although useful in itself, is doubtfully, if at all, useful in the form and relations in which it is presented to the enquirer in the book as it now stands.

The Glacial Nightmare and the Flood. A second appeal to common sense from the extravagance of some recent geology. By Sir Henry H. Howorth, K.C.I.E., M.P., F.G.S. 2 vols. 8vo. Pp. xxvii and 920. London: Sampson Low & Co., 1893. Price 30s.

Sir Henry Howorth, in the two volumes which now lie before us, stands forth as the champion of an almost universal deluge. It is not, he is careful to explain, the deluge of Noah; but it appears to be a considerably worse one, which exterminated the mammoth and could transport erratic blocks as large as houses across country for distances of many leagues. In fact the book is a nine-hundred page supplement to his bulky volume on the Mammoth and the Flood, and is to be followed by still another one. It is not altogether easy to understand the reason of the appearance of this mass of undigested extracts. The new book seems to be intended as a sort of homeopathic remedy for the "Glacial Nightmare"; but, unlike most homeopaths, the author, instead of using a small dose, attempts to cure by the exhibition of a far more serious incubus than the one we are suffering from.

The method adopted in these volumes is to put together under several heads extracts from various opinions as to the mode of formation of the Drift or Diluvium. We thus find in the first three chapters quotations from writers between 1719 and 1840, who referred the transportation of erratic blocks to the agency of water. Then follow chapters on the champions of icebergs, and of glaciers, and two more on the "growth and culmination of the glacial nightmare." We read next a chapter on the "alleged recurrence of glacial epochs and on supposed inter-glacial beds," followed by others entitled "appeals to transcendental physics and astronomy" and "meteorology." Chapters XI. to XVII. represent, apparently, the views in favour with the author, for they contain selected extracts from the evidence of such witnesses as could testify in any degree against recurrent ice ages, against a glacial period in the southern hemisphere, against the power of ice to do anything in particular, and against the occurrence at any period in regions now temperate of accumulations of ice other than large glaciers. Chapter XVIII., the author's own, is entitled "The distribution of the drift can only be explained by invoking a great diluvial catastrophe."

Sir Henry Howorth's volumes will be useful as giving references to old and forgotten writers on diluvial theories, and we have ourselves noticed several that were new to us. The more modern portions, and those relating to glaciation, are most imperfect. The Scandinavian writers who have done so much to increase our knowledge, are, for instance, almost ignored, or only quoted at second-hand from the "The Great Ice Age"; even the English and American literature of recent years has not been properly examined. After going through the two volumes carefully, and noting how time after time the author brings forward untrustworthy witnesses in favour of his own case, and omits to call the strongest on the other side, we cannot recommend the "Glacial Nightmare" to the student as giving either an accurate or impartial summary of the present state of our knowledge. We observe that the volumes are marred also by an enormous number of errors and misprints. Only ninety of these are corrected in the author's own "table of errata," but ten of the corrections are themselves wrong! Where quotations have had their punctuation or wording altered, inverted commas should not be used; and we still less like to see them inclosing inaccurate translations

from foreign memoirs. We do not intend to imply that there is any wilful distortion of the quotations, for the errors are just as numerous in those in favour of Sir Henry Howorth's own views as in those from opponents. It is merely another instance of the carelessness so conspicuous throughout the book.

---

Gun and Camera in Southern Africa: A Year of Wanderings in Bechuanaland, the Kalahari Desert, and the Lake River Country, Ngamiland. With notes on Colonisation, Natives, Natural History, and Sport. By H. A. Bryden. 8vo. Pp. xiv. and 544. Illustrated. London: Stanford, 1893. Price 15s.

South and East Africa being at the present time on the "boom," the reading public is almost overwhelmed with the number of works appearing in rapid succession on that country, its peoples, and its products. Most of these, unfortunately, have little interest for the

Head of Lechée Antelope (*Cobus lechée*)

naturalist, who too often cannot but regret that the lack of suitable training has rendered so many of the pioneers of civilisation unfitted for giving any account of the animals with which they meet. This, however, is not the case with Mr. H. A. Bryden, who has already made himself known as an observer of wild animals in their haunts, in his work "Kloof and Karroo in Cape Colony," as well as in various articles contributed to the *Field* and *Land and Water*. The present volume naturally contains a large amount of matter which is chiefly interesting to those desirous of obtaining information as to the nature of the country and its development; but there are several chapters which cannot fail to be profitable reading to the zoologist. Among these we may especially mention those bearing the titles "Natural History Notes," "The Giraffe at Home," "The Waterway and Water-fowl of the Botletli," "The Game Birds of Bechuanaland," and the "Present

Distribution of the Large Game of Bechuanaland, Ngamiland, and the Kalahari."

In the Livingstonian epoch, every book on Southern Central Africa contained accounts either of new mammals or of the countless swarms in which species previously known had been met with. Alas! these days are over; and Mr. Bryden's account of the mammals of the districts he visited is, to a great extent, one continued lament on their decadence or disappearance. Thus he speaks of hartebeest surviving only on one protected farm, and records the disappearance of the last brindled wildebeest from the districts he visited; while he confirms the general opinion as to the total extinction of the quagga. Perhaps the most interesting chapter in the whole book is that relating to the giraffe, whose last haunts in Southern Africa are the thirsty regions of the northern Kalahari and Khama's country. The author dwells on the imperfect idea we obtain of this magnificent ruminant from the dwarfed and pallid specimens seen in menageries; and urges on our museum authorities how important it is that they should obtain the skin of an old chestnut bull before it is for ever too late. He mentions that in Khama's country the giraffe is only safe during the lifetime of the present chief, but urges that one of the English companies should, when the time arrives, take up its protection. In its last native stronghold, in the northern Kalahari, the author states that there is a prospect of water being obtained (although he does not say how), and if this should be the case, and protection afforded in Khama's country be withheld, then good-bye to the giraffe in Southern Africa. Surely, under these circumstances, our Zoological Society ought to spare no expense in endeavouring to procure a pair of these animals; and as money—if only there be enough—will do most things, it ought to effect this. We may add that Mr. Bryden is convinced that, in the Kalahari, the giraffe, in common with several antelopes, never drinks.

We have not space to refer to the author's observations on other mammals and birds; but we may point to him that if he considers it necessary to add the scientific names of well-known animals—a custom we consider perfectly superfluous in a popular work, and only irritating to the reader—he might take care to use the proper ones. *Oryx capensis*, for instance, is not the correct title for the gemsbok, neither should the secretary-vulture be alluded to as *Sagittarius secretarius*. Then, again, although we are aware that it is rash to say among what strange associates any particular bird may *not* have been placed by modern systematists (!), yet we scarcely think the statement (p. 350) that jacunas "are usually placed by naturalists in the family of Palamedeidæ, or screamers, between the snipes and rails" can be accepted as up to date.

On the whole, however, the book is, for an amateur naturalist, remarkably free from zoological blunders; and while its pleasant style and beautiful illustrations cannot fail to render it attractive to the general reader, it contains many observations on the habits and distribution of South African animals which must give it a considerable amount of value to the zoological student. R. L.

---

THE NESTS AND EGGS OF BRITISH BIRDS, WHEN AND WHERE TO FIND THEM; being a Handbook of the Oology of the British Islands. By Charles Dixon. 12mo. Pp. xii. and 371. London: Chapman & Hall, 1893. Price 5s.

MR. DIXON is a prolific writer on British birds and their ways. Only recently we had to notice a respectably-sized volume on the Game-

Birds and Water-fowl from his pen, and now we have the smaller work before us. In his preface, the author tells us that the idea of the work occurred to him about a dozen years ago, since which date he has been assiduously collecting material, and, accordingly, with the numerous other works on the subject for his guidance, it ought to be as near perfect as possible. It might be thought that by this time the subject of British birds was well-nigh exhausted, but as Mr. Dixon's work treats solely of those species nesting in the British Islands, and is mainly confined to their nesting habits, it will doubtless fill a void and command a ready sale, more especially as the larger works of Morris and Seebohm, treating more or less specially of eggs and nests, are too expensive for many purses. Like all Mr. Dixon's productions, the work before us is well and pleasantly written, and the amateur naturalist, as well as every young person interested in this fascinating study, cannot do better than forthwith provide him- or herself with a copy.

Of course we miss illustrations, but as figures of eggs are not of much use unless coloured, the cost of plates would have made the book so expensive as to have defeated one of the objects of its production, and the student must accordingly do the best he can without their aid. In regard to classification, the author may be ranged among the "lumpers," seeing that he puts all the non-diving ducks in the genus *Anas*, and employs the genera *Charadrius*, *Totanus*, *Scolopax*, etc., in a wide sense. Considering, however, that there is but an interval of some two months between the date of publication of the present work and the one on Game-Birds, it seems rather a pity that he could not have definitely made up his mind what names he was going to employ, as it is rather puzzling to the beginner to find the Dotterel alluded to in one work as *Charadrius morinellus*, and in the other as *Eudromias morinellus*. Moreover, a little more attention to the index at the end of the volume would have been desirable, seeing that the word "snipe" is omitted therefrom. The mention of snipe reminds us that we consider Mr. Dixon to be wrong in persistently stating that the common species is not gregarious, although we are fully aware that the individuals do not mass together after the manner of ruffs and plovers. No one who has shot in a Bengal "jhil," with snipe rising as thick as flies all round him, can ever possibly think of these birds as being anything else but gregarious.

All these points are, however, but trifling blemishes in a volume which leaves nothing to desire in the way of "get-up," and fully deserves all the success we can wish it. R. L.

---

THE GEOLOGY AND PALÆONTOLOGY OF QUEENSLAND AND NEW GUINEA, with 68 plates and a geological map of Queensland. By Robert L. Jack, F.G.S., F.R.G.S., Government Geologist for Queensland, and Robert Etheridge, Junior, Government Palæontologist (New South Wales). 4to, Pp. xxx. and 768. Brisbane: James Charles Beal. London: Dulau & Co., 1892. Price £2 2s.

IN Europe we scarcely realise how much good scientific work is being done in our Australian colonies. Geology in particular is well studied, for the prosperity of these colonies is so largely dependent on their mineral resources, and it is so essential in an arid region to understand where water can be obtained by artesian borings, that considerable sums are willingly devoted to the making of careful

geological surveys. Queensland, though behind certain of the other colonies, has now made the very handsome contribution to geological literature which lies before us, published under the authority of the Minister of Mines.

Mr. Jack, after ten years' experience on the Geological Survey of Scotland, was appointed Geologist for Northern Queensland in 1877, and since that time has been unravelling the geology of the country and studying its minerals and mines. A number of isolated reports have already been published by himself and his assistants, and materials for the present work have been accumulating for the last fifteen years. In 1881 Messrs. Jack and Etheridge, Junr., determined to combine their labours, and published an Australian Geological Bibliography. Then followed a handbook explanatory of the exhibits in the Colonial Exhibition of 1886, which in some measure led up to the volumes which have just appeared.

So great a mass of detail and so many subjects are treated of that it is impossible critically to review the book, and we can only give an outline of its contents. Speaking generally, for the stratigraphical and mining sections, Mr. R. L. Jack is responsible, while Mr. R. Etheridge, Junr., has undertaken the palæontology. The method of arrangement adopted is mainly stratigraphical, each series of rocks, beginning with the oldest, occupying a separate section. The minerals and fossils are treated of according to the age of the deposits that contain them, instead of being relegated to separate appendices, as is perhaps more usual. In many respects this arrangement is the most convenient, but it is not altogether satisfactory, for in the absence of any subject index it is very difficult to find the references to particular minerals, unless one already knows the age of the formations in which they occur. Persons, places, and fossils are well indexed.

The oldest rocks in which fossils have yet been found in Queensland are the Middle Devonian, though below these occur various slates and schists of unknown age. Then follow unconformably the Permo-Carboniferous, Trias-Jura, and Upper and Lower Cretaceous. Between the Upper Cretaceous and the Lower Volcanic and Drifts, here doubtfully classed as Miocene, there is a wide gap, and the real age of the Tertiary rocks of Queensland is by no means settled, for fossil evidence is absent. The curious deposit of auriferous sinter at the celebrated Mount Morgan Gold Mine is considered by Mr. Jack to be of Tertiary date, though the evidence is not conclusive.

The section on Post-Tertiary rocks will be one of the most interesting to the European geologist, for in these rocks occur the remains of the wonderful extinct marsupials of Australia, and of numerous extinct birds. Discussing the question of glaciation in Australia, Mr. Jack writes: "No evidence of a Post-Tertiary Glacial Period has ever, so far as I am aware, been met with in Queensland, unless the presence of temperate plants on some of our tropical mountains be taken to afford the necessary proof." Further on, however, he mentions a recent visit to the celebrated glaciated rocks near Adelaide, in company with Professor Tate. Mr. Jack, after ten years' study of glaciation in Scotland, is a far better authority than most of the geologists who have discussed the matter, often without going to the spot, and we are interested to learn that he "came to the conclusion that Professor Tate's observation was correct in every particular, and, in addition, satisfied [himself] that the movement of the ice must have been from south to north."

The morainic *débris* has travelled from a spot forty-five miles to the south.

We have already remarked on the great importance to Queensland of its mineral wealth, and readers will not be surprised to find that a large part of this monograph relates to mines and mining. Indeed, we are somewhat surprised to see that the Government of a young country like Queensland has been so far-seeing as to understand the necessity of studying also the scientific aspects of the subject, and has gone to the expense of publishing so good a series of plates of fossils. This is as it should be, for even looked at from a purely economic point of view, it is most essential that the relations of the different deposits should be thoroughly understood, and their fossils ascertained, for the suitability of large areas for habitation depends mainly on the supply of water from artesian wells; other barren districts may be made profitable by the discovery of new mineral resources. One has, of course, no right to expect completeness at this early stage, and we think that Mr. Jack shows a thorough appreciation of the necessities of the case when he writes in his preface that "The highest function of a Geological Survey is to lay a basis for future scientific observations by accurately mapping the relations of the various formations met with in a given district." He "cannot say that this beau ideal has been reached in Queensland. In every country, and especially in every new country, it becomes necessary in the first place to give attention to districts remarkable for the presence or prospects of mineral deposits."

---

**LES ALPES FRANÇAISES; la flore et la faune, le rôle de l'homme dans les Alpes, la transhumance. By A. Falsan. 8vo. Pp. viii. and 356. With 77 figures in the text. Paris: J. B. Baillière et Fils, 1893. Price 3fr. 50c.**

WE have already noticed the first part of M. Falsan's work on the French Alps, namely, that dealing with the mountains, streams, glaciers, and meteorology, or the inorganic phenomena. The second part, now before us, treats of the animal and plant-life prevalent to-day or in past ages, as well as the part played by man. M. Falsan has been fortunate in securing efficient helpers for the special sections of his book. Thus, the Marquis de Saporta is responsible for the Palæobotany, which forms the subject of the second chapter, while, at the end of Chapter I., a general introduction by the author to the ancient Alpine flora, and its relation to the present one, the Marquis and M. Marion explain their theory "sur l'origine montagnard de la flore des Alpes."

Dr. Magnin follows, in Chapter III., with a succinct account of the vegetation of to-day, discussing, first, the influence of altitudes and the consequent modifications of species; secondly, the zones of vegetation, of which he makes four, viz.: (1) The Préalpes, or western outer Alps; (2) the granitic central Alps; (3) the south-west Alps; (4) the maritime Alps. In each case are mentioned the plants especially characteristic of the zones, and their geographical or altitudinal subdivisions. Next he briefly refers to the influence of the aspect, whether north or south, S.E. or N.W., and the nature of the soil as regards the marked difference between the vegetation of the silicious and calcareous districts, and finally discusses its relation with neighbouring regions, the central and eastern Alps, the central plain and the Pyrenees.

M. Falsan himself deals with the stratigraphical palæontology and the ancient fauna in Chapter IV., and in the succeeding chapter with the modern vertebrate zoology; while Chapter VI., devoted to the insects and molluscs, is the work of MM. C. Rey, C. Chantre, Falsan, and Locard. The Marquis de Saporta, in the next chapter, tells of the appearance of man in the Alps, his origin, and early immigrations, and traces his history upwards through the various ages to historic times, and finally, in the last, with the aid of M. Charles de Ribbe, gives an interesting historic account of his yearly transmigration with his flocks and herds, its disastrous effects, the efforts to combat the evil, dating from the Middle Ages, and the results of modern legislation. The illustrations are generally good, some of the fishes (by Leblanc) extremely so, and the publishers are to be congratulated on this valuable addition to their Contemporary Science Library.

---

THE FUTURE OF BRITISH AGRICULTURE; How farmers may best be benefited. By Professor Sheldon. Small 8vo. Pp. 158. London: W. H. Allen & Co., 1893. Price 2s. 6d.

In a series of eight chapters the author discusses some points of very vital interest to the farmer and the nation at large. The answer to the query "Will grain raising pay?" depends on whether the farmer can form a sufficiently powerful and intelligent combination to secure a fair arrangement in the relation of landlord and tenant. Protection "and that new economic craze 'Bi-metallism'" are ruled out of court. To place a duty on food imports would merely subsidise farming interests to the detriment of the rest of our industries. If we protect any we must protect all, and then we shall be no more forward. Once we were a wheat-exporting people, but since 1868 the acreage of wheat growth has fallen from nearly 4 millions to less than $2\frac{1}{3}$ millions in 1892. Canada, with its scores of millions of acres in the north-west and a favourable climate, will be the chief wheat-exporting country of the future, while mixed farming, stock, grass, grain, root, and green crops will be our mainstay.

One chapter is devoted to "the Beef of the future," another to "our breeds of sheep and how to mend them," and three to dairy farming, all of which contain valuable hints. Professor Sheldon speaks with authority, his book is well written, and promises to bring those who will read it more in touch with the agriculturist, his ways, and his difficulties.

---

CATALOGUE OF THE SNAKES IN THE BRITISH MUSEUM (NATURAL HISTORY). Vol. I. By G. A. Boulenger. London: Trustees of the British Museum, 1893. Price £1 1s.

THE first volume of this Catalogue comprises the families of Typhlopidæ, Glauconiidæ, Boidæ, Ilysiidæ, Uropeltidæ, Xenopeltidæ, and Colubridæ Aglyphæ (part), and contains descriptions of 523 species. The classification adopted is nearly similar to that formulated by Mr. Boulenger in his earlier work on the Reptilia and Batrachia of British India (1890), only some slight changes having been made in the arrangement of the genera. The Boidæ, and more especially the pythons, are regarded as the most primitive snakes; and the unnatural character of the old classification of the Ophidia into the

harmless and poisonous groups is particularly emphasised. A figure of the skull, with all the bones lettered, accompanies the definition of each family, and there are twenty-eight plates devoted to external form.

---

Au Bord de la Mer. By E. Trouessart. [Bibliothèque Scientifique Contemporaine.] 16mo. Pp. 344, figs. 149. Paris: J. B. Baillière et Fils, 1893. Price 3fr. 50c.

This is a handbook to the Geology, Fauna, and Flora of the coast of France from Dunkerque to Biarritz, and will be of considerable service to those who wander along these shores. The volume begins with a sketch of the geology, special reference being made to the cliffs, and, after touching on the littoral zones, proceeds to discuss in order, from the Algæ onwards, the life to be met with in the waters. It should form part of the outfit not only of naturalists, but also of those who desire a casual acquaintance of the animals and plants they meet with during a seaside holiday.

---

An Analytical Index to the Works of the late John Gould, F.R.S. With a Biographical Memoir and Portrait. By R. Bowdler Sharpe, LL.D. 4to. Pp. xlviii., 375. London: Henry Sotheran & Co., 1893. Price £1 16s. net.

This is a valuable index containing nearly seventeen thousand carefully verified references to the genera and species of birds and mammals described in the works and memoirs of Mr. Gould. Both the scientific and the English names are quoted, and a number of extra synonyms are added from the more recent monographs of other authors, which in a few years will have familiarised naturalists with a certain set of names not occurring in Gould's works, though the species may be duly figured therein. The Biographical Memoir is accompanied by an excellent photographic portrait, while the Index is prefaced by a detailed list of Mr. Gould's 18 folio works and 300 small papers. We congratulate Dr. Sharpe on the successful completion of his laborious task, for which ornithologists owe him a debt of gratitude. The volume is beautifully printed, and a large-paper edition has also been prepared.

---

Curtice's Index and Register of Periodical Literature. Weekly. No. 1, vol. i., April 3 to April 8, 1893. Price 6d.

This interesting new Index, which proposes to contain references to important subjects in daily newspapers, weekly, monthly, and quarterly publications, will be an invaluable help to all who are anxious to keep posted up in special subjects. It will largely depend on its fulness for its success, and the request of the promoters in asking for two copies of a journal in exchange cannot be considered unreasonable.

---

A French translation of the Right Hon. Professor Huxley's "Science and Religion" has been added to Messrs. Baillière's "Bibliothèque Scientifique Contemporaine."

Mr. Elliot Stock has just issued a literal transcription of Captain Cook's Journal during his first voyage round the world, made in H.M. Bark "Endeavour," 1768–71. This is the first occasion on which the complete original MS. has been published, and it is edited, with notes and introduction, by Captain W. J. L. Wharton.

---

Messrs. Chapman & Hall have published a new edition of Rev. H. N. Hutchinson's "Extinct Monsters." A few of the restorations by Mr. Smit have been re-drawn and improved, and a large number of woodcuts have been added to the text.

---

The Dorset Natural History and Antiquarian Field Club has issued its thirteenth volume (dated 1892). The chief things in this portly "Proceedings" (244 pp.) concerning Natural Science are, a paper by the president, Mr. Mansel-Pleydell, on the occurrence of *Lamprothamnus alopecuroides*, Braun, a Chara for which only one other British locality is known; a paper on "Some Monstrosities of *Littorina rudis*, Maton," by E. R. Sykes, in which all the specimens discussed were gathered in the Fleet Backwater, where the water becomes slightly freshened; and a contribution from the Rev. O. Pickard-Cambridge on the British Species of False-Scorpions. This last is practically a monograph, is illustrated by three excellent plates, and should prove of great assistance to those who devote themselves to Chelifers.

# NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

Mr. J. Ward, of Derby, has been appointed Curator of the Cardiff Museum.

---

Dr. Hermann von Ihering has been appointed Curator of the Zoological Department of the San Paulo Museum, Brazil.

---

Mr. Frederic V. Coville, of the Agricultural Department at Washington, U.S., has been promoted to the directorship of the Botanical Division, which recently became vacant through the death of Dr. Vasey.

---

Professor H. Newell Martin has resigned the Chair of Biology in the Johns Hopkins University, Baltimore, which he has held for seventeen years. We regret to add that the Professor's ill-health has necessitated this course.

---

Mr. John H. Cooke, B.Sc., Lecturer on Mathematics in the Maltese University, has been appointed to lecture on Geology in the same institution. Mr. Cooke will also have charge of the fossils and rock-specimens in the Museum of the University, which have hitherto been much neglected. Fortunately, nearly all the known Maltese fossils of importance are preserved in the British Museum.

---

The University of Edinburgh has conferred the honorary degree of LL.D. upon Dr. Ramsay H. Traquair, F.R.S., the eminent ichthyologist. The University of London has promoted Mr. J. W. Gregory, B.Sc., of the British Museum, to the degree of D.Sc.

---

There are several newly-appointed Professors of Botany. Mr. W. Bottomley succeeds to the Professorship at King's College, London. Dr. N. Wille, of Aas, has been appointed Professor in the University of Christiania and Director of the Botanic Gardens. Dr. Ferdinand Pax, formerly Privat-docent in the University of Breslau, has succeeded the late Professor Prantl as ordinary Professor and Director of the Botanic Gardens in that University. Professor M. Möbius, of Heidelberg, has been appointed Librarian and Teacher of Botany at the Senckenberg Institute at Frankfort, in succession to the late Dr. Jännicke. Dr. H. Mayr is the new ordinary Professor in the Forestry School at Munich. Mr. Percy Groom has been appointed Demonstrator in the University of Oxford, and Dr. Dreyer, of St. Galle, takes the place of Dr. A. Koch as Assistant in the Plant-Physiological Institute in the University of Göttingen. At Göttingen, also, the position of Assistant in the Botanical Museum and Garden, vacated by Dr. Hallier, is now filled by Dr. Giessler, formerly Assistant in the Botanic Institute at the University of Jena. Dr. Hallier, it may be added, has been appointed Assistant in the Botanic Garden at Buitenzorg, in Java.

AT a meeting held at the House of Commons on May 11, the Committee who have prepared a draft charter for a Welsh University explained their views to the Members for Wales. It is proposed that residence in the new University shall be essential for graduation, but it is hoped that a large number of valuable scholarships will be available for competition.

---

THE sum of £3,500 has been voted by the University for the improvement of the Oxford Botanic Gardens. The glass houses, according to Professor Vines, are in a very bad state of repair, besides being inadequate and old-fashioned. When the gardens were leased from Magdalen in 1876, it was stipulated the University should execute repairs at the cost of £5,580, but of this sum only £2,000 have hitherto been expended. The present vote is, therefore, a somewhat tardy fulfilment of the obligation.

---

A NEW American Marine Biological Laboratory, under the direction of Professors C. L. Edwards and A. J. Smith, is being founded at Galveston by the University of Texas. We have also received a circular from Messrs. Sinel and Hornell, of Jersey, announcing the establishment of a Biological Station in connection with their business in the Channel Islands.

---

THE Yale University, New Haven, U.S.A., is publishing bibliographies of the writings of its Professors. A useful list of the numerous contributions of Professor O. C. Marsh to Vertebrate Palæontology (1861–1892) is to hand.

---

RESEARCH as a part of Technical Education is promoted, we are glad to see, by some of the County Councils. We have just received from Dr. William Somerville a "Report on Manurial Trials in the County of Northumberland," which gives some useful results from a number of experiments on various artificial manures.

---

AMONG recent bequests, it is reported that the Marquis Ricci of Genoa has left a large sum for the foundation of a new scientific institution in his native city. The late Earl of Derby bequeathed £2,000 each to the Royal Society and Royal Institution of London.

---

MR. F. BRADY, C.E., has presented to the British Museum portions of the cores of Carboniferous rocks from the Dover boring. Several pieces of shale contain plant-remains sufficiently well preserved for identification, and they are now exhibited in the gallery of fossil plants at South Kensington.

---

THE Manchester Museum has just added to its series of useful handbooks a "Catalogue of the Types and Figured Specimens in the Geological Department." The Catalogue is reprinted from the Report of the Museums' Association for 1892. We have also received a second edition of Professor Marshall's "Outline Classification of the Animal Kingdom," which is now supplemented by an "Outline Classification of the Vegetable Kingdom" by Professor Weiss.

---

WE hear disquieting news from Brighton, where the Corporation is considering proposals for the enlargement of the museum. The Booth collection of birds, which was wisely placed by the founder in a situation as far as possible from the sea air and town smoke, is, we understand, in danger of being removed to the midst of the town, close to the shore. The Natural History collections in the museum, including the unique series of Sussex Cretaceous fossils, are also destined to be very inadequately provided for, judging from the plans we have had the privilege of inspecting. Surely, if the members of the Corporation committee are inexperienced in such matters and cannot obtain the advice of any resident naturalists, it is their duty to secure the services of an expert. We hope that wiser counsels will prevail.

We have received the third part of the second volume of the *Actes de la Société Scientifique du Chili*. Dr. Fernand Lataste contributes most of the small zoological notes, and another instalment of Borne's memoir on *Latrodectus* is published.

---

An excellent summary of the work of the Scientific Societies of Australia during the past year appears in the recently-issued *Year Book of Australia* for 1893. One new society was founded at Bathurst, New South Wales.

---

The Cothenius Medal of the German Leopold-Caroline Academy of Naturalists has been awarded to Professor Dr. Adolf Fick of Würzburg, in acknowledgment of his researches in the physiology of muscle.

---

The Geographical Society of Berlin has bestowed the Humboldt medal upon Dr. John Murray, of Edinburgh; and the Geographical Society of Paris has awarded a gold medal to Dr. Fridjof Nansen.

---

The two gold medals of the Royal Geographical Society have been awarded this year to Mr. Frederick C. Selous and Mr. Woodville Rockhill. Mr. Selous is the well-known hunter who has contributed so much to our knowledge of the "big game" of Africa. Mr. Rockhill is an American who has made many careful surveys of the "Land of the Lamas." The other awards of the Society are as follows:—The Murchison grant to Mr. R. W. Senior, of the Indian Survey; the Gill memorial to Mr. H. O. Forbes, for researches in New Guinea and the Malay Archipelago; and the Cuthbert Peek grant to Mr. Charles Hose for his explorations in Sarawak, Borneo.

---

Some months ago we referred to the fact that the Royal Geographical Society had opened its doors to women Fellows. This innovation, which was decided by the Council, instead of by a Special General Meeting of the Fellows, was looked upon as illegal and outside the jurisdiction of the Council under the Charter. A Special General Meeting, therefore, was called on April 24 last to consider the matter. Some 250 Fellows were present, and after an animated discussion, the question of admission of women as Fellows was negatived by 145 to 104. Although we heartily approve of the action of the Fellows, we are sorry to hear of this result, as we feel that the women who have been already elected Fellows of the Society have considerably more claims to the Fellowship than one-half of the male existing members. There has been for some time past much grumbling with regard to the difficulty experienced in getting a seat when some distinguished traveller is discoursing for their information, the reason being that so many ladies are admitted as visitors that numbers of the Fellows themselves are crowded out. Several circumstances account for this, one of which is that most of the meetings of the Geographical Society partake more of the evening "At Home" than of the scientific nature. At the Annual Meeting of the Society on May 29, we understand that Sir Mountstuart Grant-Duff resigns the Presidency, and Mr. Clements Markham is nominated to succeed him.

---

In the list of fifteen candidates selected this year by the Council of the Royal Society of London for election to the Fellowship, Natural Science is represented by the following names:—Professor J. Cossar Ewart, Dr. W. T. Gairdner, Sir Henry H. Howorth, Mr. E. T. Newton, Mr. C. S. Sherrington, Professor E. C. Stirling, Professor J. W. H. Trail, and Dr. A. R. Wallace. The list will be submitted to a meeting of the Fellows on June 1.

At the Soirée of the Royal Society of London on May 10, there was little novelty in the Natural History Exhibits. Colonel Swinhoe showed a series of butterflies illustrating protective mimicry; Dr. G. H. Fowler exhibited a series of oyster shells, to illustrate the various modifications and rate of growth; the Zoological Society of London contributed a collection of lepidopterous insects reared in the insect house, and the Marine Biological Station sent some marine invertebrata from Plymouth; Dr. D. Sharp illustrated the sound-producing apparatus of ants; Professor Williamson showed the microscopic structure of some Carboniferous plants, and Mr. E. Wethered the micro-organisms in limestone. Mr. H. O. Forbes exhibited bird-remains from New Zealand and the Chatham Islands, and Mr. E. T. Newton had some casts of the skulls of the extinct Triassic reptiles discovered near Elgin.

---

At the Annual Meeting of the Linnean Society on May 24, the officers were re-elected, Professor Charles Stewart retaining the presidency for another year. The newly-issued part of the *Journal* of the Society (Zoology, vol. xxiv., no. 154) contains a paper on the Buprestidæ of Japan, by G. Lewis; descriptions of Crinoids from the Sahul Bank, North Australia, by Professor Jeffrey Bell, and of Land-shells from Borneo, by Edgar A. Smith; a discussion of the affinities of the genus *Madrepora*, by George Brook; and on two new species of *Rhax*, by H. M. Bernard.

---

The *Quarterly Journal of the Geological Society* (vol. xlix., part 2), which appeared in the last few days of April, is noteworthy as containing a paper on bivalved mollusca—a subject comparatively neglected in these recent years. It is very encouraging to find, too, that the Society has not been niggardly in regard to illustrations, for no less than four plates, containing 60 figures, are devoted to Dr. Wheelton Hind's paper on *Anthracoptera* and *Anthracomya*. Dr. G. J. Hinde contributes two short papers on Radiolarian rocks; the Rev. P. B. Brodie records some Cestraciont remains from the Keuper of Shrewley; and Mr. Lydekker has a note on a Dinosaurian Vertebra from the Wealden. Mr. Wethered continues his work on the singular structure he refers to *Girvanella*, but we are not prepared yet to consider this under the head of palæontology. Petrology is represented by Mr. Simmons, "On the Petrography of Capraja"; by Miss Raisin, "On the Variolite of the Lleyn"; while Professor Judd returns once more to the controversy, carried on between Sir A. Geikie and himself, over the succession of the rocks in Skye. Messrs. Fox and Teall describe "Some Coast-sections at the Lizard"; and foreign geology is treated of by Lieut. Frederick, on the New Hebrides group, and Mr. Power, on the Pambula gold deposits, New South Wales. In the May number, too, as is the custom, the President's Address is printed *in extenso*, together with the Annual Report, with obituary of deceased Fellows. Mr. Hudleston in his address has given a critical *resumé* of the "Recent work of the Geological Society," and also a readable account of the *Quarterly Journal* for 1892, while at the same time briefly sketching British geology published elsewhere.

---

The Trinidad Field Naturalists' Club has issued pt. 7 of its first volume of Proceedings. Mr. Oldfield Thomas contributes a list of the known mammals of Trinidad, with valuable hints for collectors who can still add greatly to knowledge of the subject. Mr. J. H. Collens records some personal observations on the Trinidad manatee, which is now almost extinct; and Mr. W. M. Crowfoot furnishes a preliminary list of Trinidad butterflies. There are other minor communications, and the club appears to be in a very prosperous condition.

# OBITUARY.

## JAMES WOOD MASON.

WE regret to announce the death of Professor James Wood Mason, which took place at sea in the middle of May at the early age of forty-nine. The deceased naturalist had for some time been in failing health. He went to India in 1869 as Assistant in the Indian Museum, Calcutta, and in 1885 succeeded Dr. J. Anderson as Superintendent of that institution, and also as Professor of Physiology in the Medical College. In addition to his work in Calcutta, he undertook two expeditions (in 1871 and 1873) to the Andaman and Nicobar Islands, where he made considerable collections, and in 1880 he investigated, on behalf of the Government, the life-history of the destructive "tea-bug" in Assam. He made a special study of crustacea and insects, paying particular attention to the Phasmidæ and Mantidæ, a work on the latter group being unfortunately cut short by his untimely death. His contributions to science are contained in numerous papers in the *Journ. Asiat. Soc. Bengal*, the *Ann. Mag. Nat. Hist.*, and other journals.

---

DR. MOLESCHOTT, Professor of Physiology in the University of Rome, died on May 20 at the age of seventy. A Dutchman by birth, he became Professor of Physiology, Anatomy, and Anthropology at Heidelberg in 1847, removing nine years later to Zurich, thence to Turin, and in 1879 to Rome.

---

MR. WILLIAM COTTON OSWELL, the well-known African traveller, died on May 1 at the age of seventy-five. The death is also announced of the traveller and botanist, Dr. J. BRAUN, who had been exploring Madagascar.

---

AMONG other recent deaths we also have to record those of Mr. EDWARD VIVIAN, of Torquay, Editor of MacEnery's "Cavern Researches" (1859); of Dr. JOHN PASSERINI, Director of the Botanic Gardens in the University of Parma; of Professor FERDINAND SENFT, the veteran geologist; of Professor ROBERT HARTMANN, the German anatomist and anthropologist; and of the entomologists, E. G. HONRATH and J. BIGOT.

# CORRESPONDENCE.

### Natural Selection and Lamarckism: A Correction.

On page 337, line 17, I would ask the reader to substitute the word "evident" for the word "admitted," as I find I was in error in supposing that "it is admitted" that Natural Selection would evolve a general or widely-diffused sense of touch. Mr. Spencer's views on the matter are more extreme and exclusive than I gathered from his article. In the latest number of the *Contemporary Review*, he denies that either general or special sensitiveness of the skin results from Natural Selection. I am sorry that I misinterpreted his view on this point; but I fail to understand how a great philosopher can accept Natural Selection as a factor of evolution and yet suppose that it would play no important part in developing a sense so necessary for safety and survival as that of touch.

Wm. Platt Ball.

---

### Mr. Hick and Calamostachys.

In a paper which appears in the number of Natural Science for May (vol. ii., pp. 354–359), Mr. Hick has, if I mistake not, brought before the public for the third time his views respecting the structure and affinities of *Calamostachys Binneyana*. I am not disposed to enter upon what, to be of any value, must be a prolonged and detailed controversy; but were I to allow this paper to be circulated unnoticed by me, such a course might be equivalent to an admission that I had made serious blunders, which Mr. Hick had not only corrected, but that his evidence furnishes what he claims to be "a complete solution of the difficulty thus presented." This claim I must definitely decline to recognise. I fear that the difficulties in the way of obtaining this solution are greater than Mr. Hick realises.

For several months my friend, Dr. Scott, and I have been working together, at the Joddrell Laboratory at the Kew Gardens, re-investigating the entire subject of the Carboniferous Calamariæ, including under that comprehensive term the two genera *Calamites* and *Calamostachys*, having as material for our investigation such a collection of sections of these objects as has no existence outside my cabinets. We hope to place before the Royal Society the results of these minute and careful studies, elaborately illustrated, before the close of the present year. This memoir will be our true answer to Mr. Hick's statements. Meanwhile, that gentleman must excuse me if I decline to recognise the accuracy of a considerable number of statements contained in his paper, or admit that he has settled the controverted questions so conclusively as he claims to have done.

W. C. Williamson.

---

## *TO CORRESPONDENTS.*

*All communications for the* Editor *to be addressed to the* Editorial Offices, *now removed to* 5 John Street, Bedford Row, London, W.C.

*All communications for the* Publishers *to be addressed to* Macmillan & Co., 29 *Bedford Street, Strand, London, W.C.*

*All* Advertisements *to be forwarded to the sole agents*, John Haddon & Co., *Bouverie House, Salisbury Square, Fleet Street, London, E.C.*

Vol.

I.

II.

III.

IV.

V.

VI.

Vol. II. No. 11.

# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

JANUARY, 1893.

CONTENTS.



LONDON AND NEW YORK: MACMILLAN & CO.

PRICE ONE SHILLING NETT.

PRINTED FOR THE PROPRIETORS BY RAIT, HENDERSON & CO., LIMITED,
22 ST. ANDREW STREET, LONDON, E.C.

Vol. II. No. 12.

# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

FEBRUARY, 1893.

CONTENTS.



LONDON AND NEW YORK: MACMILLAN & CO.

PRICE ONE SHILLING NETT.

---

PRINTED FOR THE PROPRIETORS BY RAIT, HENDERSON & CO., LIMITED,
22 ST. ANDREW STREET, LONDON, E.C.

Vol. II. No. 13.

# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

MARCH, 1893.

CONTENTS.



LONDON AND NEW YORK: MACMILLAN & CO.

PRICE ONE SHILLING NETT.

# Messrs. MACMILLAN & CO.'S SCIENTIFIC BOOKS.

BY PROFESSOR CALDERWOOD.

EVOLUTION AND MAN'S PLACE IN NATURE. By HENRY CALDERWOOD, LL.D., F.R.S.E., Professor of Moral Philosophy in the University of Edinburgh. Crown 8vo, cloth, 7s. 6d.

*WESTMINSTER GAZETTE.*—"The book, which is written throughout in a lucid and attractive style, will be found of singular interest to the non-scientific reader."

BY THE SAME AUTHOR.

THE RELATIONS OF MIND AND BRAIN. By HENRY CALDERWOOD, LL.D. Third and Cheaper Edition. Crown 8vo, cloth, 8s.

COMPLETION OF PROF. MICHAEL FOSTER'S "PHYSIOLOGY."

THE CHEMICAL BASIS OF THE ANIMAL BODY. An Appendix to Foster's "Text-book of Physiology." Fifth edition. By A. SHERIDAN LEA, M.A., D.Sc., F.R.S., University Lecturer in Physiology in the University of Cambridge; Fellow of Caius College. 8vo, cloth, 7s. 6d.

*This appendix has been written upon the same lines as in former editions, save that it has been enlarged, and in reality now constitutes a treatise on the chemical substances occurring in the animal body. As in former editions, it is entirely the work of Dr. A. Sheridan Lea. The references given, though extensive, are not intended to be exhaustive. An effort has been made to make the references to recent works as complete as possible, other references are to papers, which themselves give full references, and will therefore serve as a guide to literature of the subject; and some have been inserted in order to inform the student of the dates at which important results were first described."*—From the Preface.

NEW BOOK BY MR. FRANCIS GALTON.

FINGER PRINTS. By FRANCIS GALTON, F.R.S. 8vo, cloth, 6s. net.

*TIMES.*—"The whole subject is handled with that rare patience and thoroughness in investigation, and that keen but cautious acumen in interpretation which are characteristic of all Mr. Galton's work."

WITH NEW PREFATORY CHAPTER.

HEREDITARY GENIUS: An Enquiry into its Laws and Consequences. By FRANCIS GALTON, F.R.S. New Edition. Extra Crown 8vo, cloth, 7s. net.

BY PROFESSOR HUXLEY, F.R.S.

PHYSIOGRAPHY. An Introduction to the Study of Nature. 13th Edition. Crown 8vo, 6s.

*SATURDAY REVIEW.*—"Written in that attractive style which is characteristic of a great natural history demonstrator, a style in which clearness and precision of language are combined with a vivid survey of the various objects touched upon."

*ACADEMY.*—"It would hardly be possible to place a more useful or suggestive book in the hands of learners and teachers, or one that is better calculated to make physiography a favourite subject in the science schools."

BY DR. TYLOR, F.R.S.

ANTHROPOLOGY. An Introduction to the Study of Man and Civilisation. By EDWARD B. TYLOR, D.C.L., F.R.S. With Illustrations. Crown 8vo, cloth, 7s. 6d.

*SATURDAY REVIEW.*—"If all manuals were like this, a generation over-educated for its intellect would have no reason to complain . . . Dr. Tylor's volume seems to us to serve a double purpose. It is a most attractive and entertaining introduction to the science of anthropology . . . . He has acquired the art of teaching. . . . His writing is clear and luminous, and his arrangement masterly . . . . He writes with as much learning."

SOME VOLUMES OF NATURE SERIES.

ARE THE EFFECTS OF USE AND DISUSE INHERITED? An examination of the view held by Spencer and Darwin. By W. PLATT BALL. 3s. 6d.

THE RIGHT HAND: LEFT-HANDEDNESS. By Sir D. WILSON. Illustrated. 4s. 6d.

THE APODIDÆ: A MORPHOLOGICAL STUDY. By HENRY MEYNERS BERNARD, M.A., Cantab. With 71 Illustrations. 7s. 6d.

*SCOTSMAN.*—"A book which zoologists will very greatly prize. The writer has worked out the task he set before him with the greatest care and in the most elaborate manner, and has presented the fruits of his labour in a volume which every lover of scientific investigation will thoroughly appreciate. . . . A valuable contribution to zoological investigation."

MACMILLAN & CO., LONDON.

# CONCHOLOGY.

**G. B. SOWERBY**, in constant receipt of interesting SHELLS from all parts of the world, supplies Specimens and Collections from his large and varied stock, and sends selections to amateurs on approval.

**Books by G. B. SOWERBY, F.L.S.:**

"*Thesaurus Conchyliorum*" in parts or monographs.

"*Illustrated Index of British Shells.*" Coloured figures of all known species, 30/- nett.

"*Marine Shells of South Africa*," 12/- nett.

COLLECTIONS PURCHASED.

MUSEUMS AND PRIVATE COLLECTIONS CLASSIFIED, NAMED AND ARRANGED.

**121 Fulham Road, London, S.W.**

# THE IRISH NATURALIST.

A Monthly Journal of General Irish Natural History.

**BOTANY. ZOOLOGY. GEOLOGY.**

Edited by GEO. H. CARPENTER, B.Sc., and R. LLOYD PRAEGER, B.A.

This Magazine should be in the hands of all naturalists interested in the distribution of animals and plants over the British Islands.

**Vol I. (1892) now complete. Price 3s. 6d. Vol. II. (1893) will be sent monthly to any address for 5s.**

Among the contributors to Vol. I. were Prof. G. A. J. Cole, Prof. T. Johnson, Dr. R. F. Scharff, A. G. More, Rev. W. F. Johnson, R. J. Ussher, R Warren.

Articles will also appear by the above in Vol. II., as well as by Dr. V Ball, Prof. W. J. Sollas, Prof A. C. Haddon, Prof. M. M. Hartog, Rev. H. Friend, R. M Barrington, W. F. de V. Kane.

DUBLIN: EASON & SON, 40 Lower Sackville Street (to which address subscriptions should be sent). London: Simpkin, Marshall Hamilton, Kent & Co.

*Opisthostoma mirabile,* E. Smith.

*Opisthostoma pulchellum* G. Austen.

# CONCHOLOGY.

H. F. has just acquired the grand collection of LAND and FRESHWATER SHELLS formed by the late MR. ARTHUR MORELET, probably the largest Collection ever formed by an amateur, comprising nearly 10,000 species.

**Glass-Topped Boxes, Card Trays, &c.**

**HUGH FULTON,** CONCHOLOGIST, 216 KING'S ROAD, LONDON, S.W.

# JAMES R. GREGORY,
## MINERALOGIST & GEOLOGIST.

**SPECIAL AND TYPICAL COLLECTIONS**

FOR STUDENTS, LECTURERS, MUSEUMS, &c.,

*As supplied to the Science and Art Department, South Kensington.*

**EVERY REQUISITE FOR PRACTICAL WORK.**

Also, Museum Fittings, Cases, and all Materials for Display &c., of Specimens.

**COLLECTIONS OF MINERALS, FOSSILS, & ROCKS,**

To Illustrate all Elementary Works.

*SPECIAL COLLECTIONS FOR EACH WORK.*

**NEW LISTS NOW READY,**

And may be had Post Free on application at the Repository and Museum,

**88 CHARLOTTE ST., FITZROY SQ., LONDON.**

TELEGRAPHIC ADDRESS: "ADVERTENCE, LONDON."

TELEPHONE No. 2,895.

# Rait, Henderson & Co., LIMITED.

Artistic Letterpress - - - - and Lithographic

# PRINTERS.

SPECIALISTS FOR

## BOOK, MAGAZINE & CATALOGUE PRINTING.

**ESTIMATES GIVEN PROMPTLY FOR THE FINEST WORK AT REASONABLE PRICES.**

"NATURAL SCIENCE" is a Specimen of our Printing.

Also Printers of "ANNALS OF BRITISH GEOLOGY," by Professor BLAKE, M.A. &c., &c.

**OFFICE AND WORKS:**

## 22 ST. ANDREW STREET, HOLBORN CIRCUS, LONDON. E.C.

PRINTED FOR THE PROPRIETORS BY RAIT, HENDERSON & CO., LIMITED, 22 ST. ANDREW STREET, LONDON, E.C.

Vol. II. No. 14.

# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

APRIL, 1893.

CONTENTS.



LONDON AND NEW YORK: MACMILLAN & CO.

PRICE ONE SHILLING NETT.

PRINTED FOR THE PROPRIETORS BY RAIT, HENDERSON & CO., LIMITED, 22 ST ANDREW STREET, LONDON, E.C.

Vol. II. No. 15.

# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

MAY, 1893.

CONTENTS.



LONDON AND NEW YORK: MACMILLAN & CO.

PRICE ONE SHILLING NETT.

PRINTED FOR THE PROPRIETORS BY RAIT, HENDERSON & CO., LIMITED, 22 ST ANDREW STREET, LONDON, E.C.

Vol. II. No. 16.

# NATURAL SCIENCE:

## A Monthly Review of Scientific Progress.

JUNE, 1893.

CONTENTS.



LONDON AND NEW YORK: MACMILLAN & CO.

PRICE ONE SHILLING NETT.

PRINTED FOR THE PROPRIETORS BY RAIT, HENDERSON & CO., LIMITED, 22 ST ANDREW STREET, LONDON, E.C.

CE

S,

ES,

t:

story

.L.S.,

TS OF
E, F.L.S.,
HOBKIRK,
TURNER,

, LEEDS.
al Sub-
post free.

ED.

S.

NG.

g.
M.A.

ON.